



**ESE 2020**  
Prelims Paper - I



**STANDARDS & QUALITY PRACTICES**  
IN PRODUCTION, CONSTRUCTION, MAINTENANCE AND SERVICES

# STANDARDS & QUALITY PRACTICES

IN PRODUCTION, CONSTRUCTION,  
MAINTENANCE AND SERVICES



**REVISED & UPDATED**  
315+ Objective Questions

ESE 2020  
Prelims Paper - I

# ESE-2020 Prelims Paper-I

## Standards and Quality Practices IN PRODUCTION, CONSTRUCTION, MAINTENANCE AND SERVICES



**Office :** F-126, (Lower Basement), Katwaria Sarai, New Delhi-110016 • **Phone :** 011-26522064  
**Mobile :** 8130909220, 9711853908 • **E-mail:** info.publications@iesmaster.org, info@iesmaster.org  
**Web :** iesmasterpublications.com, iesmaster.org



## **IES MASTER PUBLICATION**

F-126, (Lower Basement), Katwaria Sarai, New Delhi-110016

**Phone** : 011-26522064, **Mobile** : 8130909220, 9711853908

**E-mail** : info.publications@iesmaster.org

**Web** : iesmasterpublications.com

### **All rights reserved.**

Copyright © 2019, by IES MASTER Publication. No part of this booklet may be reproduced, or distributed in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise or stored in a database or retrieval system without the prior permission of IES MASTER Publication, New Delhi. Violates are liable to be legally prosecuted.

**First Edition** : 2016

**Second Edition** : 2017

**Third Edition** : 2018

**Fourth Edition** : 2019

# PREFACE

In today's time, minimum assured quality of products and services has become bare essential for private as well as government sectors. It is for this reason that students aspiring for Engineering Services Examination (ESE) should have a well-structured view of the standards and quality practices in production, construction, maintenance and services.

This book helps students build upon concepts from the scratch to the advanced level. From evolution of concept of quality to various thinkers and approaches, to statistical tools and accepted sampling parameters as well as six sigma standards have been discussed thoroughly. It further delves into inventory management, and touches upon various aspects of manufacturing vis-à-vis quality, maintenance and reliability.

Being an engineer is about quality assurance in whatever products and services one designs and delivers, as per established standards. Therefore, it is given foremost importance by the UPSC.

This revised and updated edition builds on all the important variables that have been cited in previous versions of Engineering Services Examination.

As one go through various topics, concepts, and illustrations, an augmented sketch of all the important issues touching standards and quality is drawn. This makes sure that whatever spin is given to the questions, one can deduce the correct answer.

Any constructive ideas, suggestions, feedbacks for improving the content of future editions will be highly appreciated.

**IES Master Publication**  
**New Delhi**

# CONTENTS

Section	Description	Page No.
	<i>Preface</i>	<i>(iii)</i>
<b>Chapter 1</b>	<b>BASIC CONCEPTS OF QUALITY .....</b>	<b>1 – 21</b>
1.1	Key Concepts Related to Quality .....	1
1.2	Types of Quality .....	4
1.3	Cost of Quality .....	5
1.4	Value of Quality .....	7
1.5	Evolution of Concept of Quality .....	8
1.6	Quality Policy .....	9
1.7	Quality Objectives .....	10
1.8	Quality Assurance (QA) and Quality Control (QC) .....	10
1.9	Quality Audit .....	11
1.10	Quality Management .....	12
1.11	Quality Improvement .....	13
1.12	Quality and Productivity .....	13
<b>Chapter 2</b>	<b>QUALITY THINKERS AND APPROACHES .....</b>	<b>22 – 43</b>
2.1	Kaizen .....	22
2.2	Benchmarking .....	22
2.3	Poka – Yoke .....	23
2.4	Ishikawa .....	23
2.5	Taguchi .....	24
2.6	Armand V. Feigenbaum .....	25
2.7	Philip B. Crosby .....	26
2.8	Deming .....	26
2.9	Joseph Juran .....	28
2.10	TQM (Total Quality Management) .....	28
2.11	Quality Function Deployment .....	31
2.12	Kano Model .....	32
2.13	Quality Awards .....	34
2.14	Value Engineering .....	35
2.15	Standards .....	35
2.16	ISO .....	36
2.17	Other Popular Standards .....	37

<b>Chapter 3</b>	<b>STATISTICAL TOOLS AND CONTROL CHARTS .....</b>	<b>44 – 57</b>
	3.1 Statistical Tools .....	44
	3.2 Errors in Making Conclusions on the Basis of Control Chart .....	48
<b>Chapter 4</b>	<b>ACCEPTANCE SAMPLING .....</b>	<b>58 – 66</b>
	4.1 Introduction .....	58
	4.2 Types of Acceptance Sampling .....	59
	4.3 Terms Associated with Sampling Inspection .....	62
<b>Chapter 5</b>	<b>SIX SIGMA .....</b>	<b>67 – 73</b>
	5.1 Statistical Concepts Related to Six Sigma .....	67
	5.2 Limitation of Three Sigma Quality .....	69
	5.3 Process Capability .....	70
	5.4 Methods used in Six Sigma .....	70
	5.5 Implementation of Six Sigma .....	71
<b>Chapter 6</b>	<b>INVENTORY MANAGEMENT .....</b>	<b>74 – 89</b>
	6.1 Introduction .....	74
	6.2 Types of Inventories .....	75
	6.3 Classification of Inventories .....	75
	6.4 Cost associated with Inventory .....	75
	6.5 Purchase Model with Instantaneous Replenishment and with Shortages .....	79
	6.6 Selective Inventory Control Techniques .....	80
<b>Chapter 7</b>	<b>MANUFACTURING .....</b>	<b>90 – 109</b>
	7.1 Introduction .....	90
	7.2 Line Balancing .....	91
	7.3 Objective of Line Balancing .....	91
	7.4 Terms Associated with Assembly Line .....	91
	7.5 Plant layout .....	92
	7.6 Product Layout .....	93
	7.7 Process Layout .....	93
	7.8 Fixed Position Layout .....	94
	7.9 Cellular or Group Layout .....	94
	7.10 Factors Affecting Plant Location .....	94
	7.11 Production System .....	95
	7.12 Job Shop Production .....	96
	7.13 Batch Productions .....	96
	7.14 Mass Production .....	96
	7.15 Material Requirements Planning .....	97
	7.16 JIT (Just in Time) Production .....	98

	7.17 Kanban System .....	99
	7.18 5S for Improvement .....	101
	7.19 Lean Manufacturing .....	102
<b>Chapter 8</b>	<b>MAINTENANCE AND RELIABILITY .....</b>	<b>110 – 124</b>
	8.1 Maintenance .....	110
	8.2 Reactive Maintenance .....	111
	8.3 Preventive Maintenance .....	112
	8.4 Predictive Maintenance .....	113
	8.5 Reliability Centered Maintenance .....	113
	8.6 Total Productive Maintenance (TPM) .....	114
	8.7 Failure Mode and Effects Analysis (FMEA) .....	115
	8.8 Reliability .....	116
	8.9 Reliability Measurement .....	116
	8.10 Systems with Components in Series .....	117
	8.11 System with Components in Parallel .....	117
	8.12 MTTF and MTBF .....	118
<b>Chapter 9</b>	<b>CONSTRUCTION AND SERVICES .....</b>	<b>125 – 136</b>
	9.1 Quality in Construction .....	125
	9.2 Quality Assurance .....	125
	9.3 Quality Control .....	126
	9.4 Elements of Quality .....	126
	9.5 Total Quality Management (TQM) .....	127
	9.6 Services .....	129
	9.7 Service Quality Dimensions (RATER) .....	130
	9.8 Five Gaps of Service Quality Model .....	131



# IES MASTER

Institute for Engineers (IES/GATE/PSUs)

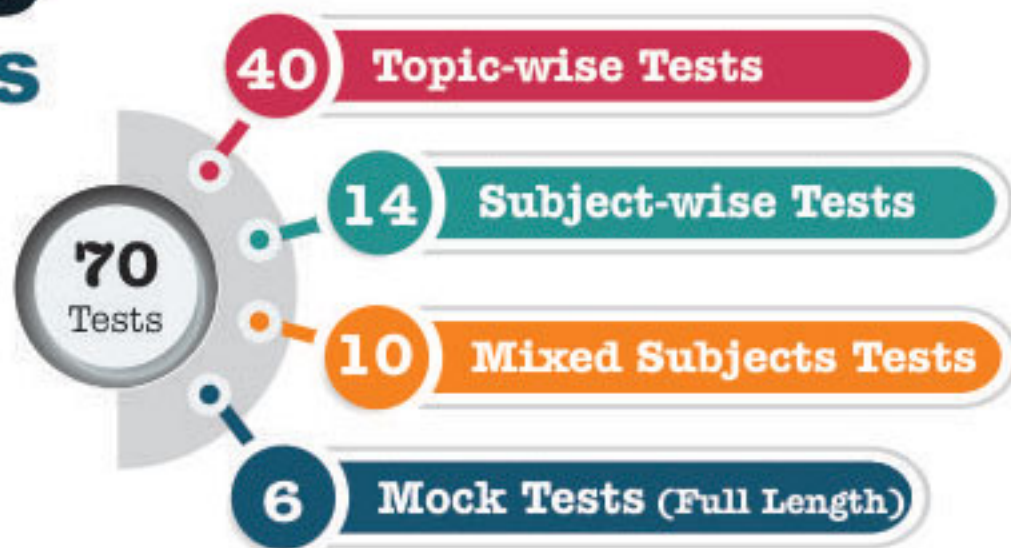
Starts on  
**21 Apr**

## GATE 2020 Online Test Series

- Matches level & orientation of GATE
- Thoroughly researched test papers
- Improve speed, accuracy & time management
- Track & monitor your performance

Call 97118 53908, 80100 09955

[Register Now](#)





# Basic Concepts of Quality

## 1.1 KEY CONCEPTS RELATED TO QUALITY

### INSIDE

- ❖ Key Concepts Related to Quality
- ❖ Types of Quality
- ❖ Cost of Quality
- ❖ Value of Quality
- ❖ Evolution of Concept of Quality
- ❖ Quality Policy
- ❖ Quality Objectives
- ❖ Quality Assurance and Quality Control
- ❖ Quality Audit
- ❖ Quality Management
- ❖ Quality Improvement
- ❖ Quality and Productivity

- ❖ Quality depends on the degree of fitness for use by the customer. Hence, a product will have good quality if it is suitable for the purpose for which it is meant. However, the term, fitness for purpose, is a highly subjective term, the interpretation of which may vary from individual to individual. The criterion of fitness for purpose is perfectly suitable at only one stage of production of a product or service. This is the stage of designing the product. The marketing department of the company prepares a product definition document in which it specifies the expectations and requirements of the customer from the product. This document is passed on to the design department where the designs of the product are prepared keeping in mind the fitness for purpose i.e. the expectations of the customer. The designs so prepared are rated good or bad according to the extent to which these are able to satisfy the requirements mentioned in the product definition document. In all the subsequent stages such as development, engineering, production, distribution and after-sales service, quality is measured in terms of conformance to specifications. During the development of the product, various specifications are evolved. These specifications have to be adhered to in all the stages of production in order to achieve the desired quality of the product. Conformance to these specification can be verified by the objective evidence in contrast to the subjective approach of the fitness for purpose criterion.
- ❖ Quality of a product means the conformance to specification. The customer's needs have to be assessed and translated into specifications.
- ❖ The product or service must meet the customer's expectations or needs. The needs can be both stated as well as implied.
- ❖ The product or service should be cost effective or economical. Due to increased competition, the companies have to continuously improve their products' function and reduce wastages to reduce cost.
- ❖ Reliability is an important indicator of quality over a period of time. It means that the product must perform its intended function over a period of time without failing under given operating conditions.
- ❖ The product should be serviceable. It means that the after-sales service of the product should be quick, cheap and easily available. In the face

of intense competition today, an important dimension of quality which was overlooked so far by many Indian companies is customer service. In India, the domestic industry can overcome the threat of foreign MNCs by focussing on this aspect of quality. Manufacturing organisations must focus on after-sales service as an important opportunity for making a difference in quality to gain competitive advantage.

- ❖ The product should be durable. Durability means the effective life of the product after which it can no longer be used even after repair.
- ❖ The product or service should have good perceived quality.
- ❖ The product must also have good aesthetics and it should be safe in handling.
- ❖ Quality is a relative term. It is not absolute. It varies with time, space and from person to person.
- ❖ Stiff competition at the national and international level and customer's awareness about the quality of goods and services have made it necessary that companies put increased emphasis in achieving the desired customer satisfaction by running its business at an economical level.
- ❖ Feigenbaum defines quality as : The total composite product and service characteristics of Engineering, Manufacturing, Marketing and Maintenance through which the product and service in use meet the expectations of the customers. Efforts should be made to incorporate the quality at the design stage and maintained in manufacturing which the customer would like to have and is willing to pay for it.
- ❖ The product must perform its intended function repeatedly as called upon, over its stipulated life cycle under normal conditions of use. It should be easy to operate or use.
- ❖ The survival of the company depends on the income it gets from selling its products and services, and the ability to sell is based on fitness for use. Hence, the company's functions concerned with quality or achieving fitness for use are known as quality functions. It includes variety of activities. Every one working in the factory or all departments are responsible for the broad quality function. With the aid of market survey, a company determines what qualities are needed by the customers.
- ❖ Research and development specialists create a product concept which can meet these quality needs of the users. Design engineers prepare product and material specifications considering the quality requirements. Process engineers specify the processes, machines and instruments capable of producing the products with the desired quality, and inspecting them. Purchasing specialists buy materials and components possessing appropriate qualities. Operators are trained to use the process and instruments to make the product as per the design. Inspectors examine the product to judge conformance with the design. Consumers use the product and the experience of use becomes the basis for a redesign, or improvement in the product, which starts the cycle all over again.
- ❖ Quality is a perceptual, conditional, and somewhat subjective attribute and may be understood differently by different people. The perception of quality of a product or service from the point of view of a customer may be different from that of the producer. The problem of the producer is aggravated by the fact that the number of customers may be too large and each one may have a different perception about quality. Consumers may focus on the specific quality of a product/service, or how it compares to competitors in the marketplace. Producers might measure the conformance quality, or degree to which the product/service was produced correctly. Support personnel may measure quality in the degree that a product is reliable, maintainable, or sustainable. If a third party such as a quality certification agency has to decide about the quality of the product or service, its perception may be different from those of the customer and the producer.
- ❖ In the early 1900s, pioneers such as Frederick Taylor and Henry Ford recognized the limitations of the methods being used in mass production at the time and the subsequent varying quality of output, implementing quality control, inspection, and standardization procedures in their work. Later in the twentieth century, the likes of Deming and Juran helped take quality to new heights, initially in Japan and later (in the late '70s and early '80s) globally.
- ❖ Customers recognize that quality is an important attribute in products and services, and suppliers recognize that quality can be an important differentiator between their own offerings and those

## Questions

1. Which of the following statements correctly define Quality?
  - (i) Meeting both internal and external customer's expectations.
  - (ii) Degree of excellence at an acceptable price.
  - (iii) Fitness for use or purpose.
  - (iv) Meeting product specifications.

(a) Only (i), (ii) & (iii)    (b) Only (i) and (iii)  
 (c) Only (ii) and (iv)    (d) All of above
2. Consider the following statements:
  1. The terms such as delighting customers, robustness, reducing variability can be associated with quality.
  2. The driving force to determine the level of quality that should be designed into a product of service is the customer.
  3. Reliability does not have a time dimension.

Which of the above statements are correct?

(a) 1 and 2                      (b) 2 and 3  
 (c) 1 and 3                      (d) 1,2 and 3
3. Read the following statements and select the correct option.
  - (i) Quality of design enables achievement of required product features and characteristics.
  - (ii) Quality of conformance enables achievement of freedom from deficiencies.

(a) Only (ii) is true.  
 (b) Both (i) and ii) are false.  
 (c) Both (i) and (ii) are true.  
 (d) Only (i) is true.
4. Consider the following statements:
  1. Quality of design is influenced by many factors, such as product type, cost, profit policy, demand of the product, availability of parts and materials, and product reliability.
  2. Quality of conformance is basically meeting the standards defined in the design phase after the product is manufactured or while the service is delivered.
  3. Quality of Performance measures the degree to which the product or service satisfies the customer from the perspective of both quality of design and the quality of conformance.

Which of the above statements are correct?

- (a) 1 and 2                      (b) 2 and 3  
 (c) 1 and 3                      (d) 1,2 and 3

5. Consider the following statements:

1. Cost of quality is a methodology that allows an organization to determine the extent to which its resources are used for activities that prevent poor quality, that appraise the quality of the organization's products or services, and that result from internal and external failures.
2. Having such information allows an organization to determine the potential savings to be gained by implementing process improvements.

Which of the above statements are correct?

- (a) 1 only                      (b) 2 only  
 (c) both 1 and 2              (d) none

6. Match the following:

**List I**

- A. Prevention cost  
 B. Appraisal cost  
 C. Internal failure cost  
 D. External failure cost

**List II**

1. Arise from detecting defects through inspection.
2. Arise from defects that actually reach customers.
3. Arise from efforts to prevent defects from occurring at all.
4. Arise from defects caught internally and dealt with by discarding or repairing the defective items.

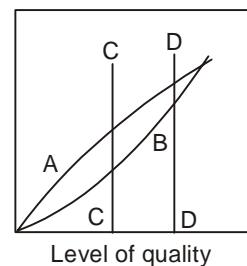
Which of the following is true?

- (a) A-3, B-1, C-4,D-2  
 (b) A-1, B-3, C-4,D-2  
 (c) A-3, B-1, C-2,D-4  
 (d) A-1, B-3, C-2,D-4

7. Which of the following costs are not included in the cost of prevention?

- (a) Quality planning
  - (b) Training and workforce development
  - (c) Product design verification
  - (d) Test and inspection of purchased materials
8. Which of the following statements is not correct regarding cost of quality?
- (a) Out of prevention cost, appraisal cost, internal failure cost and external failure cost, the most expensive cost of quality is the external failure cost.
  - (b) The most effective way of achieving the highest quality at the lowest cost is by developing robust and reliable processes that produce quality product on a consistent basis.
  - (c) Efforts should be made to reduce the internal failure costs to zero as internal failures produce scrap.
  - (d) It is not possible to reduce the activities of inspection even by developing robust processes.
9. **Assertion :** If the level of defect is high, it means the company has invested more in prevention and appraisal.  
**Reason :** As the level of defect decreases, the cost of non-conformance decreases.
10. In reference to Total quality cost (TQC) which of the following statements are correct:
- (i) TQC consist of "Cost of conformance" and "Cost of non-conformance"
  - (ii) Cost of conformance implies expenses required for producing quality product.
  - (iii) Cost of non-conformance is loss because of defects in the product.
- (a) Only (i) and (ii) are correct.
  - (b) (i), (ii) and (iii) are correct.
  - (c) Only (i) is correct.
  - (d) Only (i) and (iii) is correct.
11. Which of the following costs will be included in cost of prevention?
- (i) Cost of quality planning.
  - (ii) Cost of training of workers to make quality products.
  - (iii) Cost of information collection and analysis about number and types of defects.
  - (iv) Cost of retest after rectification of a product

- (a) Only (i) (ii) and (iii)
  - (b) Only (i) (iii) (iv)
  - (c) Only (iii) and (iv)
  - (d) Only (ii) and (iv)
12. Any cost arising out of claim of customer regarding a defective product within its guarantee period should be included in
- (a) Appraisal Cost
  - (b) Cost of internal failure
  - (c) Cost of external failure
  - (d) Prevention cost
13. What should the company focus on to achieve quality more economically?
- (a) External Failure Cost
  - (b) Internal Failure Cost
  - (c) Prevention Cost
  - (d) Appraisal Cost
14. Which of the following quality costs are failure costs?
- (a) Customer Survey Cost
  - (b) Calibration Cost
  - (c) Product recall cost
  - (d) Pre-dispatch inspection cost
15. The graph shows the results of various quality levels for a component



Consider the following statements:

1. Curve A shows the variation of value of components
2. Curve B shows the variation of cost of the component
3. The preferred level of quality is given by line CC
4. The preferred level of quality is given by line DD

Which of these statements are correct?

- (a) 1, 2 and 3
- (b) 2, 3 and 4
- (c) 1, 3 and 4
- (d) 1, 2 and 4

## ANSWER KEY

1. (d)	8. (d)	15. (a)	22. (d)	29. (d)	36. (a)
2. (a)	9. (d)	16. (d)	23. (c)	30. (b)	37. (b)
3. (c)	10. (b)	17. (b)	24. (b)	31. (d)	38. (d)
4. (d)	11. (a)	18. (a)	25. (c)	32. (d)	39. (a)
5. (c)	12. (c)	19. (a)	26. (c)	33. (b)	40. (a)
6. (a)	13. (c)	20. (c)	27. (a)	34. (a)	
7. (d)	14. (c)	21. (c)	28. (d)	35. (a)	

## EXPLANATIONS

1. (d) All above statements are definitions of quality given by different quality gurus.
3. (c) Both statements are true as quality in design ensures that product features required by the customer are incorporated in product's design and expressed as product specifications. Quality of conformance ensures that there is no gap between actual product features and designed specifications.
10. (b) Cost of conformance is the price paid for prevention of poor quality (to avoid failure in product or services) and cost of non-conformance which is the of losses incurred due to failure of product or service because of poor quality. Thus, TQC will depend on how much an organisation is spending to prevent poor quality and how much cost it is incurring because of failures due to poor quality. Mathematically,
- $$\text{TQC} = \text{Cost of Conformance (COC)} + \text{Cost of non Conformance (CONC)}.$$
11. (a) (i) (ii) and (iii) are the components of Prevention Cost while (iv) i.e. Cost of retest of a product after its rectification shall be added to cost of internal failures.
12. (c) Cost of failures in a product within its warranty period after it has been sold to the customer is added to cost of external failure.





## Scan to Download IES Master App



### Features

- ✓ Daily updates
- ✓ Timely notifications
- ✓ On the fly bookmark of important notes and questions
- ✓ Practice questions on all topics
- ✓ Study materials - in the form of notes, quizzes and videos

## Pocket the Knowledge

As a maverick ESE/GATE platform, we embark upon being your learning partner, in your pursuit of excellence.

True to the likings of engineering students, here, information comes crisp, compact and exact, accompanied by myriad of illustrations that one's eyes can feast upon, and brain to exercise and hone its capabilities. We believe that illustrations speak louder than words; and figurines communicate faster than complex wordy pages.

As your eyeballs roll through the app, concepts on all topics – from Material Science to Currents, right from the ESE and GATE toppers - shall come alive before you.

In the swarm of devices based on touch-based, smart technology, IES Master App literally manifests its belief that a right 'touch' can change one's world.



Also visit @

[iesmaster.org](http://iesmaster.org) | [iesmasterpublications.com](http://iesmasterpublications.com)



Like us on facebook  
[/iesmaster1](https://www.facebook.com/iesmaster1)



Follow us on twitter  
[/ies\\_master](https://twitter.com/ies_master)



Watch us on youtube  
[/iesmaster1](https://www.youtube.com/iesmaster1)



[amazon.com](https://www.amazon.com)

[Flipkart](https://www.flipkart.com)

[snapdeal](https://www.snapdeal.com)



<https://iesmasterpublications.com>



## IES MASTER PUBLICATION

F-126 (Lower Basement), Katwaria Sarai, New Delhi-110016

Phone : 011 26522064, Mobile : 97 1185 3908

E-mail : [info.publications@iesmaster.org](mailto:info.publications@iesmaster.org), [info@iesmaster.org](mailto:info@iesmaster.org)

Web : [iesmasterpublications.com](http://iesmasterpublications.com)

₹ 200.00

