CPE 591 Note

⇒ Professions that use Reliability: Quality research, measurement science, different areas of Engineering

Reliability is the probability that a system will perform a required function for a given period of time when used under stated operating conditions.

Military Standard Definition

It is the probability that an item will perform a required function without failure under stated conditions for a stated period of time.

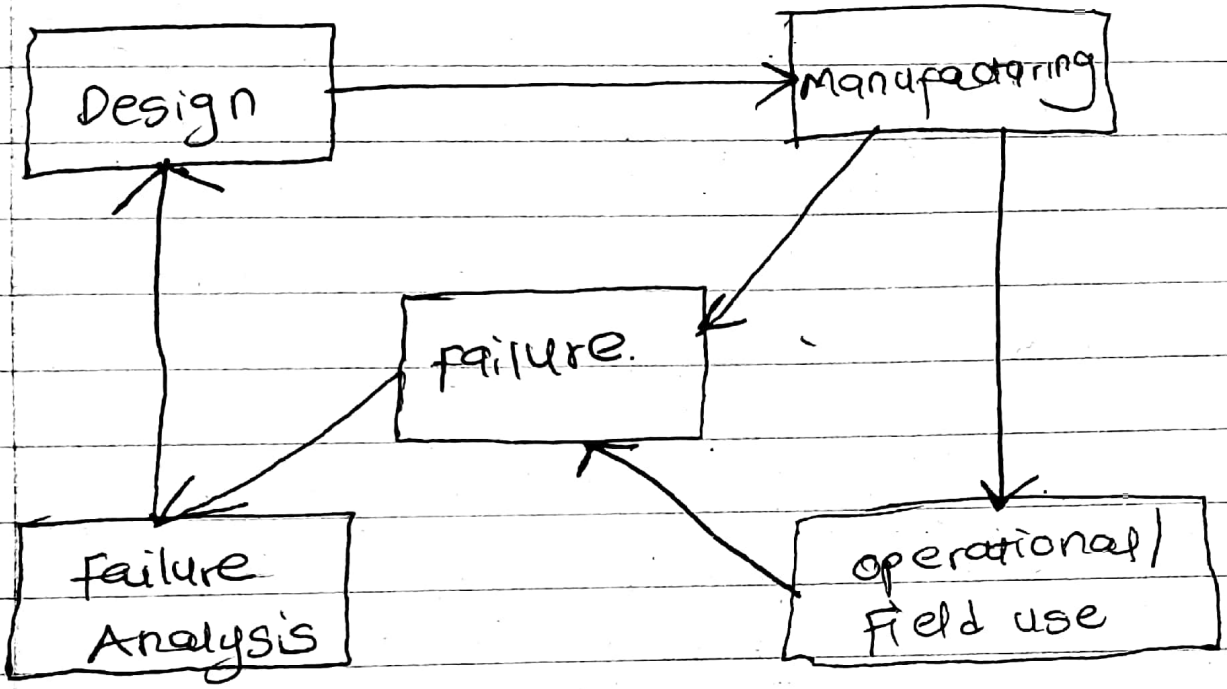
NB Reliability is always stated in relations to mean time Between failure (MTBF)

Reasons for the Pressures.

1. Rapid advance in technology
2. The development of highly sophisticated products
3. There is intense global competition
4. There is an increase in the expectation of customers.

A typical process of reliability in the design and manufacturing of quality products

is illustrated below'.



Design Module Questions that the Developer needs to ask himself/herself.

(1) Do the parts (components) meet their reliability goals at design stage, and if not, how is the reliability to be improved?

(2) How are the different material characteristics to be assessed?

(3) What are the appropraite method to estimate the part reliability?

(4) How is the effect of a proposed design

change assessed?

Manufacturing Process Questions

① Can the manufacturing process produce parts that meet the reliability goals?
② Which vendor supplies the most reliable parts?
③ Is burn-in necessary for all production parts to meet the reliability goals?
④ Does the production line continously produce reliable parts?
⑤ What specific evidence is there to ~~topper~~ the customers to show that the product meets reliability goals?

Operational/Field use Questions

① What reliability test can be shown to the customers?
② Are the customers going to have reliability problems if they by the products?
③ What are early estimates of warranty

cost?

④ How are two or more different manufacturing method or product from two or more manufacturers to be compared?

⑤ What are the methods employed in accessing part reliability?

Failure/Failure Analysis Modules questions

① What are the different failure modes operation?

② What is the failure rate and the cumulative failure distribution of a particular component while it is employed under the STATED CONDITION?

③ What is the difference between Mean time Between failure (MTBF) and Mean time to Repair?

④ Are there opportunity exit to improve a part or system performance?

⑤ What type of reliability testing are appropraite?

⑥ What should be the accelerated stress

condition to be used to induce early failures?

RELIABILITY

The concept of reliability is the engineering part that relates to cost of failure, that is caused by system downtime, which includes the cost of spare part, equipment repair, and warranty

Reliability engineering is used to apply scientific know-how to a component, product, plant or process to ensure it performs its intended function without failure, for the required time duration in a specified environment.

Two significant dimensions to reliability

① Time

② Stress (temperature, vibration, voltage)

These puts a strain on the component

Maintainability

This is defined as the degree of facility with which an equipment is capable of being retained in or restored

to sereviceable operation.

factors to consider to have satisfactory maintainability

1. The equipment or machine could fail
2. The positioning of maintenance display, checkpoint, guages, meter and the position of one assemble with respect to another.
3. The limitation imposed by the human frame
4. The environment in which maintenance or repair will be carried out.
5. The design of test equipment
6. Presentation of information in the maintenance and repair manual.

Maintainability basically has to do with correcting defect, addressing the cost to prevent a future reoccurence

It has to do with us repairing and replacing.

It also ensures that you prevent unexpected working conditions (maximizing product lifetime)

Reliability Specification and Metrics

Reliability is defined as the probability that an item is able to perform its intended functions without any form of failure for a specified period of time under stated conditions.

During the design and specification of reliability, it is important to identify the operating condition of the item, as well as what truly constitutes proper functioning of the said item or component.

The breakdown of a system is as a result of failure of a component that can be repaired or replaced

For a repairable component, the rate of

MTBF

reoccurence of the problem is an important characteristics when rating reliability.

MTTF

For a replaceable component, the lifetime of the component is an important factor that affects the reliability of that system.

Reliability is a function of the environment where the component is being operated and stress on the system

Conditions of use Obtainable in an environment:

The conditions of use includes but not limited to;

① Environment of operation: Temperature Season of the year, operating time, dust, vibration, acoustic environment, shock, etc. These are some of the environment functions that could influence

or exert stress on the system.

(2) Maintenance as specified

(3) Operations within design specification

An operational perspective must be presented as early as possible.

Reliability specification requires a clear description of what constitutes mission success/failure for a system when its operational.

Conditions of use can be presented through narratives or specific

In narratives - Brief description of anticipated conditions. A brief description ~~In specific~~ is given on how the system will operate

In specific:

Essential elements of reliability Specification

Measurable ① It must have a quantitative statement of the reliability requirement.

Customer usage and operating Conditions * ② A full description of the environment where the system is expected to be stored, transported, operated and maintained.

Time ③ The time measure or mission profile

Failure definition ④ A clear description of what constitutes failure.

Confidence * ⑤ A description of the test proeedure with accept/reject that will be used to specify the reliability

* Reliability requirement which is formed inside the reliability specification, predicts how a particular item will perform in the future.

Essential element of reliability requirement

① The quantity should be measurable (reliability metrics)

② Customer usage and operating condition.

③ Time

④ Failure definition.
⑤ Confidence

Four(4) ways to define reliability requirement:
① Mean time between failure (long life systems form of reliability distribution is not too critical)
② Probability of survival for a specified period of time (defining reliability when a high reliability is required during mission period)
③ Probability of success independent of time (specifying reliability of one-shot devices such a flight system of missles)
④ failure rate over a period of time. (specifying reliability of parts, assemblies whose mean lives are too long to be meaningful)

Reliability requirement definitions:
① Nominal or designed value with which the customer will be satisfied.
② A minimum accepted value below which the customer will find the the system totally unacceptable and could not be tolerated in a value based operational environment.

Whichever value is chosen, two rules must apply:
① When a nominal value is specified as a

requirement, it always specify a minimum acceptable value which the system must exceed.

(2) When a minimum value is used to specify a requirement, it always ensures that it is clearly defined as minimum.

RELIABILITY METRICS

Reliability metrics ~~is~~ are used to determine the cause of failure for the purpose of predicting the reliability of a system accurately.

Failure Rate (λ)

Failure rate is the total number of failures within an item population divided by the total time expended by that population during a particular measurement interval under stated conditions

Hazard Rate

NB: Hazard rate is also known as instantaneous failure rate.

This occurs at any point in the life of an item. It is the incremental change in the number of failures per associated incremental change in time.

Mean time Between failure

This is the average time during which all parts of the item perform with their specified limits during a particular measurement period under stated conditions

NB: The mean time between failure is basically used to measure the reliability of repairable items.

Mean time Between Maintenance

This is the avg. time between all system maintenance action. It is used to measure reliability of repairable field system.

Mean time Between Repair

This is defined as the avg. time between all system maintenance action requiring the removal and replacement or in situ repairs of a box or subsystem.

NB: MTBR is used to measure reliability of repairable field system.

Mean time between Critical failure

This is a measure of system reliability which includes the effect of any fault tolerance that may exist. The avg. time between failures that causes a loss of a system function defined as critical by the customer

Mean time between Operational mission Failure

This is the avg. time between operational mission failures which causes a loss of the system mission as defined by the customer.

Mean time to failure

It is the avg. failure free operating time during a particular measurement period under stated conditions.

NB: MTF is used to measure the reliability of non-repairable system.

To-Do

* Look out for calculations of reliability metrices and learn how to solve them.

Basic concept of Maintenance

Maintenance is the work undertaken to either repair or restore a particular system to its operational condition.

* Maintenance has to do with servicing, repair and replacement.

We have two types of maintenance

① Preventive maintenance: Routine maintenance aimed at preventing failure.

* Preventive maintenance is scheduled and done regularly but corrective maintenance is not scheduled (one of the difference)

NB: Worn out components and parts are usually replaced in preventive maintenance

② Types of Preventive Maintenance

① Time based Preventive maintenance

- It is scheduled in a timely manner

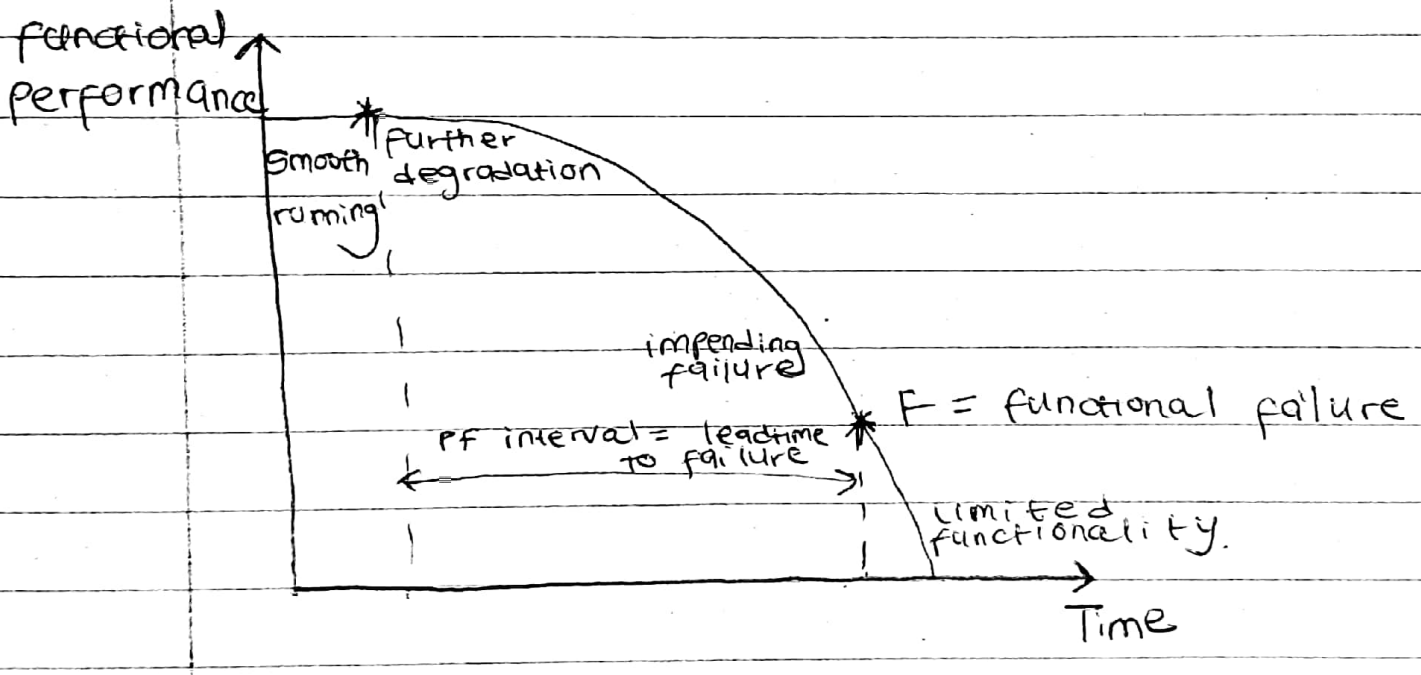
② Failure finding preventive maintenance
- scheduled to look out for hidden pauts

③ Risk-based Maintenance

NB: It involves the use of risk maintenance methodology

④ Condition-based Maintenance

Maintenance done on the basis of the warning sign given by the system.



⑤ Predictive maintenance

It is an extension of condition based maintenance with a more advanced approach where potentially many process

parameters gained from online censors are used to determine if an equipment is moving away from stable operating condition & heading towards failure.

(2) Corrective maintenance

- You don't plan for it.

Types of Corrective Maintenance

(1) Deferred (2) Emergency

Defferred CM refers to any situation in which the equipment is allowed to degrade further or remain non-functional before maintenance is carried out.

Emergency CM is the perm of maintenance required for an equipment which experienced an unexpected breakdown or sudden change in operation.

NB: Emergency maintenance is about 3 to 5 times as expensive as normal preventive maintenance.

Typically, emergency maintenance results in a longer equipment outage or downtime and it is not safe.

Typically, Emergency maintenance results in a longer equipment outage or downtime and it is not safe.

NB: It is safe to say that emergency maintenance is the one and only maintenance strategy that should be avoided at all cost.

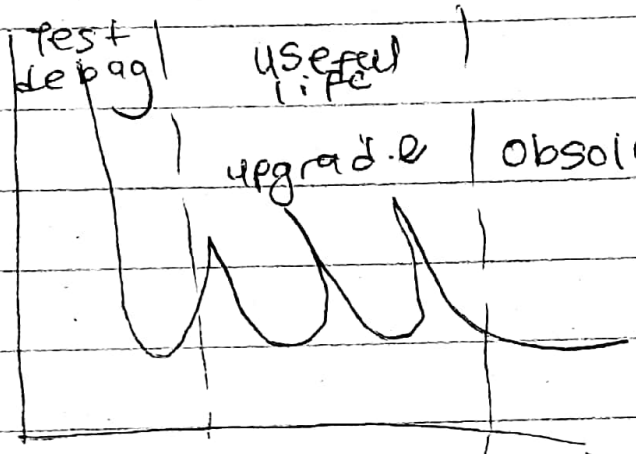
Software Reliability

Sop

⇒ failure free operation, specific condition

Software reliability is the ability of a system to have a failure free operation in a specified time period

Reliability is a function of time.



Software failure curve.

The upgrade represents feature upgrade. For feature upgrade, the complexity of the software is likely to be increased. Since the functionality of the software is enhanced. Even bug fixes may be a reason for more software failure.

The Test debug represent the stages of testing and debugging the software.
The useful life of the software stage, upgrades are carried out.
The obsolete represent the wear out of the software.

To manage this, there are three fault management strategies:

i) fault avoidance: In this step, development techniques are used to either minimize the possibility of mistakes or to trap mistakes before they result into the introduction of system fault.

ii) Fault detection and removal
Here, involves verification and validation techniques that increase the probability of detecting and correcting errors before the system goes into service.

iii) Fault tolerance: Here runtime techniques are used to ensure that system fault do not ~~lead to~~ result in system errors and/or that system errors do not lead to system failure.

Availability

This is the probability that a system at a point in time would be operational and able to deliver the requested services.

$$A = \frac{\text{Uptime}}{\text{uptime + downtime.}}$$

There are two types of reliability requirements or reliability metrics.

① Non-functional reliability requirements

These are the specifications of all the required reliability and availability of the system using the following

i) Probability of ~~the~~ failure on the demand

Probability that the system will fail when a service request is made.

ii) Rate of occurrence of failure
= No of failures / total no. of hrs

iii) Availability.

(2) Fundional reliability requirements
This specifies the fault to be detected and the actions to be taken to ensure that these faults do not lead to system failure.
There are four types of fault tolerance systems
(1) Protection system.
(2) Self-monitoring architecture
(3) N-vision programming
(4) Hardware fault tolerance.

} Make notes on them

Next class
- Difference btw hardware & Software reliability
- Software quality.

Software Quality control → Product or Service

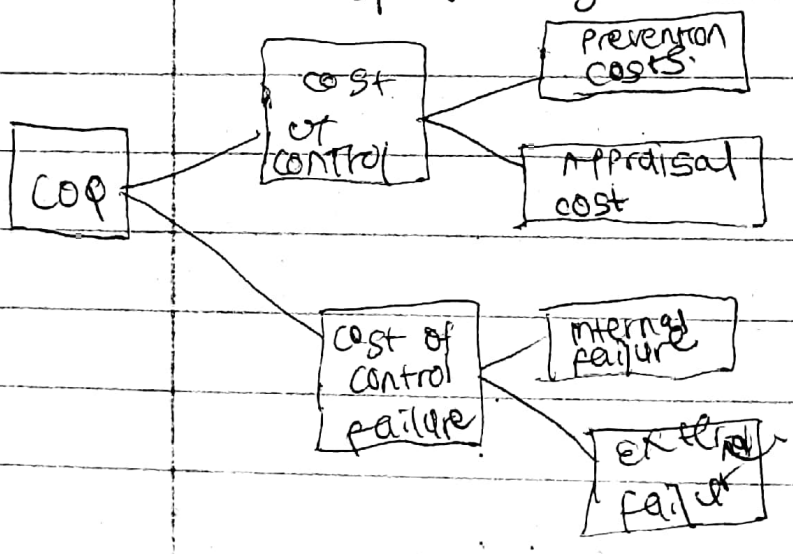
Software quality assurance → process

Software quality is the rating of a software a defined generalized software design standard.

Read up quality assurance specifications
" " Fault Tree Analys

Three methods to pay close attention to for determining fault.
① FTA ② FMEA ③ HAZOP.

Cost of Quality =



BASIC MAINTENANCE PROCEDURES OF COMPUTER AND DIGITAL COMMUNICATION SYSTEMS

four maintenace procedures for computer Systems.

1. You must update your operating system.
2. We uninstall programs we do not use
3. Update your device drivers
4. It is important that you clean up your disk.

Assignment

What are the basic maintenance procedures for digital communication systems. (submitting next week)

BY PRUDENCE

FAULT TROUBLESHOOTING TECHNIQUES

Fault can be defined as an abnormal condition or defection in a component, equipment or subsystem level which may lead to a possible failure

Causes of fault ADD W MUDI

1. Design error
2. Implementation Error
3. Maintenance error
4. Usage
5. Wear
6. Deterioration of the system
7. Damage
8. Aging

Consequences of Fault: HELL WE WE

1. Worse performance
2. Energy waste
3. Waste of raw materials
4. Economic losses
5. Lower Quality
6. Lower Production

⑦ Exronmental Damages
⑧ Haman Damage

There are two types of fault:

① Random fault: occurs as a result of wear of any form of deterioration of the equipment.

NB: In practical application, we cannot ~~the~~ determine the time within which the component will wear out

The rate at which random fault occurs within the equipment can be predicted accurately

② Systematic fault: occurs as a result of error in the specification of the equipment. The truth is that, systematic errors may not be detected for many years.

NB: ~~Faults~~ failures that occur in hardware are usually as a result of random faults or systematic faults.

AB: failures that occur in software are usually as a result of systematic faults, and it is tied to error in specification of the particular software.

Fault Detection involves identifying or discovering the cause of a failure in a hardware or software component or equipment.

Early detection of a fault can help prevent abnormal event progression.

Fault detection can be achieved through the following methods:

(1) Traditional techniques

i) Involves trying to detect fault using our senses.

ii) Using simple meter tests

ii) Using components data books or service manuals.

(2) Model-based Approach

(3) Use of Multi-Variables

④ Use of Statistical process control measures (SPC).

Basic Fault Detection Guides

① Check that all the components are in their correct positions.
② Check that there are no short circuits.
③ Perform some basic electrical testing to ensure that power is being supplied to all parts of the circuit.
④ Check to see if all the components are functioning properly
⑤ Check if overheating during component soldering damaged any of the components.
⑥ Detach and test any suspected components using appropraite test equipments
⑦ Carefully examine the circuit voltage / current using appropraite test equipments
⑧ When the equipment is connected to another equipments carefully check for

compatibility problems by testing on an alternative equipment.

Audio Faults

Audio faults which may not require immediate action pending when other testing may be carried out. The audio may be a mere humming sound coming out of the audio amplifier. This usually occurs due to a faulty power supply component, faulty diodes and transistors. At times, it may be vibration of the transformer connection due to inadequate clamping.

Detecting Fault using Sense of Smell

Faulty components may produce characteristic odours indicating failure. For example, a burnt component such as the transformer winding, can produce a characteristic smell.

Selenium rectifier produces garbage-like smell while a high voltage corona discharge produces a smell of ozone.

Detecting fault using Sense of Touch

A component may malfunction or even fail when there is a change in temperature. for example, some components such as semiconductors, capacitors may become faulty when the equipment warms up above the ~~required~~ recommended standard temperature, yet operates satisfactorily again when the equipment cools down. ~~Tes~~

Test equipments include multi-range meters, Digital voltmeters, Insulation testers, Oscilloscope and Variable alternators. These equipments are used to test for fault. ///. More specialized equipments such as Distortion meters, Noise measuring

set, spectrum Analyzer, Phase meter and function generators. They are used to detect pulse parameters.

Information Contained in a Service Manual

① Circuit diagram showing how the components are connected electrically
② It contains the code number and value of each component.
③ It has the test point, voltages and waveform of each point.
④ It has a table showing component values tolerance and the correct voltages of waveforms at the various test points
⑤ Photographs or drawing showing the actual location of each component
⑥ A fault-finding guide which gives a list of symptoms, faults and possible causes and solutions It provides a procedure in which all the tests are placed in a logical order and the possible outcome of one test

is used to select the next test to be made

Component data book: ~~Provides you with the equi~~ A component data book is usually availabie for each class of components for example diodes & transistors. It provides performance data and a list of equivalents for all types of components or equipments, in common use.

Assignment

Discuss the different sophisticated methods for detecting faults.

CPE 591 - ENGR DELE.

Statistical Quality control.

=> Fishbone diagram.

7QC, 7 supp

SQC and SPC - has 1 added tool

Quality assurance certification

① ISO-9000 *
② ISO-9000-3
③ CMM I

} used to ascertain level of quality each body provides

→ specific for software related services

* Process documentation - Document your process to carry out a particular task

* Risk management is how you deal with different threats that could cause system failure

* TQM involves satisfying your customer's needs at the right quality (Total quality Managem.

Test Question

① What is reliability?

② There are 14 Software Quality control methods. Describe 8.

③ Describe the Software failure curve.

Quality Control

Quality control is a procedure or set of procedures to ensure that a manufacture product or performed services adheres to a defined set of quality criteria or meet the requirement of a client or customer.

Quality Assurance

Quality assurance refers to the confirmation that specified requirements have been met by a product or service.

Procedures followed to implement effective quality control

1. The organization must first decide which specific standard the product or service must meet.
2. The extent of quality control action must be determined. for example, the percentage of unit to be tested for each lot.
3. The real world data must be collected. For example, the percentage of unit that fails and the result to be reported to the

management personnel.

4) Corrective actions must be decided upon and taken. for example, the defective unit must be repaired or rejected.

5) The quality control process must be an ongoing process to ensure that remedial efforts if required have produced satisfactory results and to immediately detect any reoccurrence and new instance of trouble.

Benefits of Quality Control

1) It leads to a reduction in product defects. Reduction in product defects lead to less variable cost associated with labour and material

2) Reduction in wastage, scrap $ pollution

3) Ability to produce quality products over longer periods of time

4) With quality maintenance, need for inspection reduces leading to decrease in maintenance cost.

5) Large pool of satisfied customers.

⑥ Increase in employee's motivation and awareness of quality.
⑦ Increase in productivity and overall efficiency

Techniques for Quality Control
The two techniques employed for quality control are:
① Inspection
② Statistical Quality Control

Inspection involves periodic checking and measuring before, during and after the production process. We have two type of inspection.
i) Centralized inspection
ii) floor inspection.

Centralized inspection involves having all the work (job, product) from a department, sent to the inspection department before sending it to the next operation.

floor inspection follows the practice of

sending inspectors to the floor and the inspectors inspect work at the machine of the operatives.

Advantages of Centralized Inspection

(1) Ensures impartial supervision.
(2) It is easier to keep records of items or parts which are approved or rejected.
(3) Production work is liable to less interruption.

Advantages of Floor Inspection

(1) Since work is inspected on the floor, delaying in sending work to the next station is avoided
(2) Inspectors can immediately locate faults and suggest rectifications.
(3) It involves minimal material handling

9qc

This is based on the law of probability. It is a system used for controlling the quality of production within specified

limits (tolerance limits) by means of a sample procedure and continuous analysis of inspection result

It is important to note that SQC does not produce quality products. It merely informs management that things are not going as they ought to, this could then prompt management on the need to take necessary actions to remove the causes of variation and ensure the production of quality products

There are two techniques for SQC:

① Process control

The checking up of quality characteristics under process control is done with the help of charts. There are different types of charts: x-chart, R-chart, C-chart, p-chart.

These charts are similar in composition and structure and they all represent how quality characteristics is changing

from one sample to another

Advantages of control chart

① Provide visual aid

② Easy to prepare

③ Give early warning of trouble

② Acceptance Sampling

This is mostly used when the nature of the process used to manufacture products remains unchanged. In acceptance sampling, the decision about the quality of batches or lots are made after inspection of only a portion. If the sample of items conforms to requisite quality level, then the whole batch from which the sample is taken is accepted If the sample does not conform to the requisite quality level, then the whole batch is rejected

Advantages of Acceptance Sampling

① Less expensive than 100% inspection.

② It is used when 100% percent inspection is not possible.

③ It is useful when inspection may cause damage or complete destruction.

Advantages of Statistical Quality Control

① Reduced cost

② Early warning of defects

③ Simple techniques that can be handled by semi-operators

④ Continuous inspection

⑤ Adherance to specification

Exam

* Questions will be practical questions e.g why should a maintenance Engr invest in quality control for his/her business. Advice the person.

591 - ENGR DECE

- Statistical Quality Control
- Explain Programming for Reliability
  To explain or describe something:
  → Definition
  → Diagram
  → Functions / uses
  → Parts

* He is not bothered about history.
  In programming for reliability explanation, you should be able to talk about the 8 points.

- You can't talk about TQM without talking about Customer Loyalty & Satisfaction

- Expect some questions that are not strict.

- Quality Assurance Certifications
  Know the main levels of CMMI & understand what CMMI talks about

- Difference between FMEA, HAZOP & FTA
- Types of FMEA
- 7 QC tools & 7 supplemental tools (Use & understand them)
- Be able to fully understand Histogram
- Calculation of Cost of Quality
- Read everything Under Risk Management Strategies

CMMI
5 steps
about