

ME6012 -MAINTENANCE ENGINEERING

2 MARK QUESTIONS WITH ANSWERS

Unit I - Principles and Practices of Maintenance Planning

1. Define maintenance?

Maintenance is the routine and recurring process of keeping a particular machine or asset in its normal operating conditions

So that it can deliver the expected performance or service without any loss or damage.

2. Define reliability?

Reliability is defined as the probability that a component /system, when operating under given condition, will perform its intended functions adequately for a specified period of time. It refers to the like hood that equipment will not fail during its operation.

3. State the benefits of reliability analysis in industries?

The main advantages of imposing reliability requirements are increased productivity and reductions in forced outage equipment due to planned maintenance activity.

4. Define failure rate?

Failure rate is the ratio of the number of failures during particular unit interval to the average population during that interval.

This failure rate is also known as hazard rate and instantaneous failure rate.

5. What is Mean Failure Rate?

The mean failure rate h is obtained by finding the mean of the failures rates for specified period of time.

6. Define Mean Time to Failure.

Let t_1 is the time to failure for the first specimen, t_2 is the time to failure for the second specimen and t_n is the time to failure

for the N th specimen. Hence the mean time to failure for N specimens

$$\text{are MTTR} = (t_1+t_2+\dots+t_N) / N$$

7. What is Mean Time between Failures (MTBF)?

Mean Time between Failures (MTBF) is the mean or average time between successive failures of a product. Mean time between failures refers tom the average time of breakdown until the device is beyond repair.

8. Define Mean Time to Repair (MTTR)?

Mean Time to Repair is the arithmetic mean of the time required to perform maintenance action. MTTR is defined as the

Ratio of total maintenance time and number of maintenance action.

$$\text{MTTR} = \text{Total maintenance time} / \text{Number of maintenance action.}$$

9. Define Maintenance Action Rate?

Maintenance action rate is the number of maintenance action that can be carried out on equipment per hour.

10. Define Failure Density?

Failure Density is the ratio of the number of failures during a given unit interval of time to the total number of items at the very beginning of the test.

11. State the types of reliability?

Reliability can be generally of two types:

(i) Inherent Reliability: It is associated with the quality of the material and design of machine parts.

(ii) Achievable Reliability: It depends upon other factors such as maintenance and operation of the equipment.

12. Draw the equipment life cycle and name the various phases in it?

Phase I - Failure pattern inherent in a new product because of manufacturing or design defects.

Phase II - Life period of an equipment

Phase III - Failures due to wear out conditions because to aging of the equipment.

13. Define maintainability?

Maintainability is defined as the probability that a unit or system will be restored to specified working conditions within a given period when maintenance action is taken in accordance with the prescribed procedures and resources.

14. Define availability?

Availability is the ratio of the time at which equipment is available for the designated operation/service to the total time of operation and maintenance of the equipment. It is also defined as the ratio of equipment uptime to the equipment uptime and downtime over a specified period of time.

15. State the advantages of life cycle cost analysis.

(i) Integration of engineering, economics and financial aspects lead to the way of robust metric for the selection and purchase equipment required for the industry.

(ii) Reduced operating and maintenance cost of equipment due to cost analysis over span of time.

(iii) It leads to the selection of proper and economically viable equipment.

16. Draw the curve to determine the economic life of equipment?

The economic life of equipment depends on the maintenance and repair costs, availability and operational efficiency. A plot of cumulative efficiency and maintenance and repair cost per cumulative hours Vs operating hours of the equipment to find the economic life of the equipment is shown in the figure.

17. State the components of maintenance cost?

The maintenance cost is comprised of two factors:

(i) Fixed cost: This includes the cost of support facilities including the maintenance staff.

(ii) Variable cost: This includes the consumption of spare parts, replacement of components and cost other facilities requirements of maintenance.

18. State the role of maintenance budget

The maintenance budget is used to set aside certain amount of money to meet the expenditures incurred in achieving the objectives of maintenance.

19. State the types of maintenance budget?

(i) Appropriation Budget: Budget used to allocate money for each activity independently.

(ii) Fixed Budget: Fixed used to allocate money for a specified period of time.

(iii) Variable Budget: Dynamic allocation of expenditure based on maintenance requirements and activities.

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Unit II - Maintenance Policies – Preventive Maintenance

1. Define the term Preventive Maintenance?

It is a maintenance program which is committed to the elimination or prevention of corrective and breakdown maintenance. It is designed for day to day maintenance like cleaning, inspection, lubricating, retightening etc. to retain the healthy condition of equipments.

2. Define predictive maintenance?

Predictive maintenance is a management technique that uses regular evaluation of the actual operating conditions of plant equipment, production systems and plant management function to optimize total plant operation.

3. What is meant by Breakdown maintenance approach?

It is a type of maintenance approach in which equipment is allowed to function / operate till no failure occurs that no maintenance work is carried out in advance to prevent failure.

4. Classify various planned maintenance approach.

1. preventive maintenance
2. corrective maintenance
3. predictive maintenance
4. condition based maintenance

5. Define corrective maintenance approach.

Corrective maintenance is the program focused on regular planned tasks that will maintain all critical machinery and system in optimum operation conditions

6. What is meant by preventive maintenance approach?

A comprehensive preventive maintenance program involves periodical evaluation of critical equipment, machinery to detect problem and schedule maintenance task to avoid degradation in operating conditions. It is designed for day to day maintenance like cleaning inspection, lubricating, retightening etc. to retain the healthy condition of equipments.

7. List the objectives of corrective maintenance?

1. Elimination break downs
2. Elimination deviations from optimum operating condition.
3. Elimination unnecessary repairs

8. What is meant by predictive Maintenance?

Predictive maintenance is a management technique that uses regular evaluation of the actual operating conditions of plant equipment production systems and plant management functions to optimize total plant operation.

9. list out some condition based monitoring techniques and briefly discuss on them.

1. Vibration monitoring
2. thermograph
3. tribology
4. electrical motor analysis

10. What is meant by reliability centered maintenance (RCM)?

Reliability centered maintenance is one of the well-established systematic and a step by step instructional tool for selecting applicable and appropriate maintenance operation types. It helps in how to analyze all failure modes in a system and define how to prevent or find those failures early.

11. What is total productive maintenance and discuss its similarities with TQM?

Total productive maintenance is a maintenance program which involves a newly defined concept of maintaining plants and equipments. The goal of tpm program is to significantly increase the production, at the same time increasing employee morale and job satisfaction.

12. What is meant by reliability centered maintenance?

Reliability centered maintenance is one of the well-established systematic and a step by step instructional tool for selecting applicable and appropriate maintenance operational types.

13. What does safety, health and environment pillar of TPM aims at?

This pillar aims at achieving Zero accident, Zero health damage and Zero fires.

14. What is limitation of breakdown maintenance?

1. Most repairs are poorly planned due to time constraint caused by production and plant management. This will cost three to four times than the same repair when it is well planned.
2. This approach focus only on repair or the symptoms of failure and not on the root cause of failure. This results only in increase in the frequency of repair

and correspondingly the maintenance costs.

15. list the benefits of implementing preventive maintenance.
 1. It maintains the equipment in good condition to prevent them from bigger problems.
 2. Prolongs the effective life of the equipments.
 3. Detects the problem at earlier stages.
 4. minimizes/eliminates the rework/scrap and helps in reducing the process variability
 5. Significantly reduces unplanned downtime.

16. Name the five S principles used for implementations of TPM.
 1. SEIRI – Sort out
 2. SEITON –Organize
 3. SEISO – Shine workplace
 4. SEIKETSU – Standardization
 5. SHITSUKE – Self discipline

17. List the various pillars of TPM?
 1. 5,S Principle
 2. jishu hozen(JH)
 3. Kaizen
 4. planned maintenance
 5. Quality maintenance.
 6. training
 7. office TPM
 8. Safety, health and environment

18. What are the objectives of TPM?
 1. to achieve zero defects
 2. achieve zero accidents and zero break downs in all functional areas of an organization
 3. to create different team of people to have active participation.
 4. To aim at minimization of defects and
 5. To inculcate autonomous policy.

19. Name the various stakeholders of maintenance scheduling.
 1. Operators
 2. Planners
 3. Schedulers
 4. Maintenance supervisors
 5. craftsman
 6. Store's in charge
 7. operation superintendent

20. Define Maintenance Scheduling.

Maintenance scheduling is a joint maintenance operations activity in which

maintenance agrees to make the recourses available at a specific time when the unit can also be made available by operations.

Unit III - Condition Monitoring

1. What is equipment health monitoring?
Conditions monitoring is one of the maintenance methods which are used to assess the health and condition of equipments machines, systems or process by absorbing checking, measuring and monitoring several parameters. This technique is also called as equipment health monitoring.
2. List down the factors for increasing the demand condition monitoring
 1. Increased quality expectations reflected in produces liability legislation
 2. Increased automation to improve profitability and maintain competitiveness
 3. Increased safety and reliability expectations
 4. Increased cost of maintenance due to labour and material cost.
3. List down the key features of condition monitoring.
 1. Links between cause and effect
 2. Systems with sufficient response
 3. Mechanisms for objective data assessment
 4. Benefits outweighing cost
 5. Data storage and review facilities.
4. Write down the basic steps in condition monitoring.
 1. Identifying critical systems
 2. Selecting suitable techniques for condition monitoring
 3. Setting baselines
 4. Data collection
 5. Data assessment
 6. Fault diagnosis and repair
 7. System review
5. What are three types of condition monitoring
 - a. Subjective condition monitoring
 - b. Minimized breakdown costs
 - c. Improved morality of the operating personnel and safety.
6. State the advantages and disadvantages and disadvantages of condition monitoring.
Advantages
 1. Improved availability of equipment
 2. Minimized breakdown cost
 3. Improved reliabilityDisadvantages
 1. Gives only marginal benefits

2. Increased running cost
 3. Sometimes difficult to organize
7. Mention the various costs involved in costing of condition monitoring
mainly I. Installation cost
II. Operating cost
8. State the methods of measuring vibration
- a. Amplitude
 - b. Frequency
 - c. Phase
9. Name the types of pyrometers.
1. Total radiation pyrometers
 2. Infra red pyrometers
 3. Optical radiation pyrometers
10. Mention the application of bimetallic strip.
1. Bimetallic strips are frequently used in simple ON – OFF switches.
 2. The bimetal strips are also used in control switches.
11. List down the features of RTD.
1. High degree of accuracy
 2. Resistance thermometer is interchangeable in a process without compensation or recalibration.
12. State the application and limitation of thermistors. Applications:
1. It is used for varying temperatures
 2. it is used in time delay circuits
 3. Thermistors are used for temperature compensation.
13. What are two main types of infrared thermography?
1. Passive thermography
 2. Active thermography
14. What are the principles very important for the study of eddy current test .
- i. Permeability
 - ii. Conductivity
 - iii. Material thickness
 - iv. Edge effect and end effect
 - v. Lift off
 - vi. Fill factor
15. Describe the limitation of eddy current test.
- The main limitation is the low penetration of parts being examined, using limited to thin walls or near surface flaws. It is difficult to use on ferromagnetic materials.
- False indications are possible because of mixed variables, edge effects and lift-off

effects. Extensive technical knowledge is required for the development of inspection procedures, specific probes and to interpret the inspection data.

16. Mention the effect of X-rays to human body?

- I. Injuries to superficial tissue
- II. General effects on the body, particularly the blood forming organs; eg. Producers of anemia and leukemia
- III. Induction of malignant tumors.
- IV. Genetic effects.

17. What are the limitations of ultrasonic test?

- a. Unfavorable geometries and coarse anisotropic grain structures are difficult to inspect.
- b. extensive technical knowledge is required for the development of inspection procedure.
- c. Parts that are rough, irregular in shape, very small or thin or not homogeneous are difficult to examine, specific probes and to interpret the inspection data.

18. Name some of the methods of leakage monitoring.

1. Interstitial monitoring
2. level monitoring
3. Vapor monitoring
4. Liquid Monitoring

19. Define Seebeck effect?

The basic principle of thermocouple is 'when two dissimilar metals are joined together and emf will exist between the two points A and B, which is primarily a function of the junction temperature. The above said to be principle of Seebeck effect.

20. State the various methods of corrosion monitoring?

- d. Weight loss method
- e. Electrical resistance method
- f. linear polarization method
- g. corrosion potential measurement
- h. Ultrasonic testing
- i. Sentinel hole method.

Unit IV - Repair Methods for Basic Machine Element

1. Define the term failure.

The term failure may be defined as

1. any loss that interrupts the continuity of production
2. a loss of assets availability
3. the unavailability of equipment
4. a deviation from the status quo
5. not meeting target expectations
6. Any secondary defect.

2. What are the various possible causes for a failure ?

- Unexpected and unintentional damage \
- Workmanship
- Improper design
- Manufacturing defects
- Incorrect usage of equipment

3. Define failure analysis?

Failure analysis is the process by which information/data about failure occurring in equipments/ systems are collected and analyzed to find the root cause of failures, and the causes are addressed to prevent recurrence of failures.

4. Name the three types of failure models?

- Predictable failure model
- Unpredictable failure model
- Running-In-Failure model

5. What are called age-dependent failures?

Time dependent failures are called age dependent failures

6. What are predictable failures?

In spite of all the working conditions maintained at same level, the cause of failure will be random in nature and cannot be assigned to any particular mechanism of failure. This type of failures is called Unpredictable Failures.

7. What are Running In Failures?

Suppose if some components/ equipments are installed with unnoticed defects, may fail in a short duration after installation than during its useful life. This type of failures is Running In Failures.

8. Define Fault tree diagrams

Fault tree diagrams are logic block diagrams that display the state of a system in terms of the states of its components.

9. Write down the capabilities of Fault Tree Diagram.

1. Fault tree analysis and failure modes and effects analysis,
2. Design for reliability
3. Design for safety

10. Define Event tree Analysis

An event tree is a visual representation of all the events which can occur in a system. As the number of events increases, the pictures fans out like the branches of a tree

11. What is the aim of event tree analysis?

The aim of event tree is to determine the probability of an event based on the outcomes of each event in the chronological sequence of events leading up to it. By analyzing all possible outcomes, we can determine the percentage of outcomes which lead to the desired result.

12. Define Root cause analysis?

RCA is a step by step method that leads to the discovery of faults first or root cause. Every equipment failure happens for a number of reasons. There is a definite progression of actions and consequences that lead to a failure. An RCA investigation from the end failure is back to the root cause.

13. Define FMEA?

FMEA is methodology for analyzing potential reliability problems early in the development cycle where it is easier to take actions to overcome the issues, thereby enhancing reliability through design.

14. Define Risk Priority Number(RPN)

Risk priority numbers is the product of the numerical severity, occurrence and detection ratings.

$$RPN = (S) \times (O) \times (D)$$

15. Name the factors based on the satisfactory performance of gears/drives.

- I. Proper design and manufacture of drive
- II. Selection of proper type and size
- III. Proper installation

- V. Proper maintenance of unit in it entire life.

16. Name the factors that contribute to tooth breakage.

The common reasons for gear tooth breakage may be due to any of the following reasons

- a. Fatigue
- b. Heavy wear
- c. Overload
- d. Cracking

17. list some of the inspection performed on gears

1. Pitch error
2. Axial and
3. Radial run out
4. Tooth profile etc.

18. Name some of the geometric properties that are checked for guide ways.

1. Straightness
2. Flatness
3. Parallel both on horizontal and vertical surfaces.

19. What are the factors influence the performance of sleeve bearings.

The following are the factors that affect the bearing performance:

1. Dirt
2. Fatigue
3. Hot Shot phenomenon and
4. Crush problem

20. Define Crush

Normally, the bearings are manufactured so that they are slightly longer circumferentially than the mating housing. The bearing will be elastically deformed during assembly. If the amount of crush is insufficient, relative motion occurs between the bearing and its bore, which causes fretting and makes the bearing back a highly polished or pitted.

Unit V - Repair Methods for Material Handling Equipment

1. State few examples of material handling equipments.

Material handling equipments include carts, hand trucks, fork lifts, conveyors, shelf pickers and other specialized industrial trucks powered by electric motors or internal combustion engines.

2. State the benefits of proper maintenance of material handling equipments.

The benefits of a maintenance program for material handling equipments are to maintain the high efficiency, keep them in running condition, reduce the cost of repairs, safer operation and enhanced productivity.

3. State the major stages in preventive maintenance of material handling equipments. There are three stages of preventive maintenance are:

1. Inspection
2. Repair and
3. over haul

4. State the various phases present in a good maintenance management system.

1. Work identification
2. Planning
3. Scheduling
4. Execution
5. Recording and
6. Analysis

5. Define the term computerized maintenance management system (CMMS) Computerized maintenance management system is the application of computers in planning, scheduling, monitoring and control of maintenance activities.

6. State the objectives of CMMS.

1. Maintenance of existing equipments
2. Inspection and service of the equipment
3. installation or revamping of the equipment
4. Maintenance storekeeping
5. craft administration

7. State the advantages of CMMS.

1. Improve maintenance efficiency
2. Reduce maintenance costs

3. Reduce the equipment downtime by proper scheduling preventative maintenance.
 4. provide maintenance reports in specific formats depending on the requirements.
 5. Quicker access to plant maintenance statistics
8. Define work order system.
Work order system is the information system used by the industry to keep track of its maintenance works.
9. Mention the use of work order backlog.
Work order back log is used to find out all active maintenance works order in an industry.
10. What is work permit?
Work permits are components of work order. Maintenance department issues work permits to different executing agencies permitting them to start their work.
11. What is job card?
Job cards contain necessary details for performing individual job in maintenance organizations. Job card may be in the form of a card, sheet or printout.
12. State the benefits of job card system.
1. Information about maintenance history
 2. Knowledge of frequency of frequency of maintenance for equipments
 3. Details of equipments which require maximum resources
 4. Helps in job auditing
 5. Evaluation of cost of maintenance.
13. State the role equipment records in maintenance.
Equipment records are information containing the details of installation, service, repair, maintenance activities, schedules and plans for future implementation. Equipment records are to be used to maintain control on maintenance cost, reliability and availability.
14. State the benefits of keeping equipments records.
1. clear picture about the details of maintenance programmes is obtained.
 2. information about completed, pending and regular jobs carried out to the equipment are available
 3. Records disseminated to various units of the industry.
 4. Helps in standardization of procedures.
 5. Evaluation of performance of maintenance tasks.
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