WINTER– 14 EXAMINATION

Subject Code: **17531(PE)** **Model Answer**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.

2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and Communication Skills.

4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.

5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.

6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.

7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q 1 a) (i) Industrial water distribution system

After complete treatment of water, it becomes necessary to distribute it to a number of houses, estates, industries and public places by means of a network of distribution system. The distribution system consists of pipes of variable sizes, valves, meters, pumps, distribution reservoirs, hydrants, stand posts etc. the pipe line carry the water to each and every part of the industries, streets and road. Valves control the flow of water through the pipes. Meters are provided to measure the quantity of water consumed by individual as well as the town. Hydrants are provided to connect the water to the fire fighting equipments during fire. Service connections are done to connect the individual building with the water line passing through the streets. Pumps are provided to pump the water to the elevated service reservoirs or directly in the water mains to obtain the required pressure in the pipe lines. Requirements of water used for industrial purposes differ significantly.

Following are the some requirements of a good distribution system-

-the water should reach to each building in industry with the required pressure head.

-sufficient quantity of treated water should reach for the domestic and industrial use.

-the distribution should be economical easy to maintain and operate.

-it should be able to transport sufficient quantity of water during emergency such as fire-fighting.

-during repair work, it should not cause obstruction to the traffic.

For distribution of water, Gravity system, pumping system and dual system or combined gravity and pumping systems are used depending on the requirements of the industries.

Q 1 a) (ii) Difference between Preventive and Scheduled Maintenance (Any two points)

Preventive Maintenance:

- A system of schedule, planned or preventive maintenance tries to minimize the problem of breakdown maintenance
- It is a stitch in time procedure
- It locates weak spots such as bearing surfaces, parts under excessive vibration etc. in all equipments, provides them regular inspection and minor repairs thereby reducing the danger of unanticipated breakdown. The underline principle of preventive maintenance is that prevention is better than cure.

Scheduled Maintenance:

- Schedule maintenance is a stitch-in time procedure aimed at avoiding breakdowns.
- Breakdowns can be dangerous to life and as far as possible should be minimize.
- Schedule maintenance practice incorporates inspection, lubrication, repair and overhaul of certain equipments which if neglected can result in breakdown.
- Schedule maintenance practice is generally followed for overhauling of machines; cleaning of water and other tanks, white washing of buildings etc.

Q 1 a) (iii)

Total Productive Maintenance (TPM) is a maintenance program which involves a newly defined concept for maintaining plants and equipment. The goal of the TPM program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction.

TPM brings maintenance into focus as a necessary and vitally important part of the business. It is no longer regarded as a non-profit activity. Down time for maintenance is scheduled as a part of the manufacturing day and, in some cases, as an integral part of the manufacturing process. The goal is to hold emergency and unscheduled maintenance to a minimum.

Important features of TPM

1. Adoption of life cycle approach for improving the overall performance of production equipment.
2. Improving productivity by highly motivated workers which is achieved by job enlargement.
3. The use of voluntary small group activities for identifying the cause of failure, possible plant and equipment modifications.

Q1. a. (iv) (List 2 marks, details – 2 marks)

- **SPECIFIC GRAVITY**
  Specific gravity is the ratio of the weight of a given volume of substance at 60 degree F. to that of water.
- **VISCOSITY**

  Viscosity is a measure of the oil's resistance to flow. The more the viscosity of the oil more will be its resistance to flow, e.g. compare water and molasses. Water is less viscous and hence flows freely. Whereas molasses, which has a high viscosity, flows sluggishly. An ideal oil film on a bearing depends on selecting an oil with the right viscosity to maintain separation of two metal surfaces. The speed of the journal and viscosity are closely allied in maintaining a good oil film in the bearing. The slower the journal speed, the higher viscosity or thicker oil we must use. As journal speeds are increased, a thinner of lower viscosity oil is needed. Bearing loads must also be considered because the oil must have sufficient viscosity to maintain a good oil film to support the load.
- **VISCOSITY INDEX**

  Viscosity index is an expression of effect of change of temperature on the viscosity of oils. This change can be evaluated numerically and the result is expressed as V.I.

- **POUR POINT**
- Pour point of an oil is an important quality. It is a temperature at which oil will still remain fluid. It reflects on the capability of the oil to work at low temperatures.

FLASH POINT

Flash point is the temperature at which the oil gives off sufficient vapors which can be ignited. It reflects on the capability of the oil to work at higher temperature without any fire hazard.

Q 1 b) (i)

Every preventive maintenance work should be pre-planned in detail on the basis of analysis done on the passed records. A scheduled programme thus prepared should be followed strictly. Thus programme should be in detail specifying the point requiring daily, weekly, monthly, half yearly or yearly attention

In Planning of maintenance work involves the following steps (3 Marks)

- Anticipation of maintenance work
- Visualization of the nature and details of that work
- Determination of the best method to perform the work
- Arranging for the required material
- Securing alternations in production programme or scheduling of maintenance work to confirm to production plans
- Allocation of work to individuals
- Instructing the individuals about the schedules and methods
- Following up and checking of work
- Evaluation of the work and performance.

In Scheduling of maintenance work involves the following steps (3 Marks)

- System should be clear, precise and easy to operate
- Should be based upon accurately determined time standards
- Should be finalize in consultation with production department so that the equipments for maintenance purposes can be spared
- Should aim at creating a balanced work load on each trade section in the department, that is, each section should be evenly loaded.
-

Q 1 b) (ii)) (List 2 marks, details – 2 marks each)

The methods for lubricating machine elements can be divided into following categories.

- Manual Devices
- Drop-feed Devices
- Splash or bath lubrication
- Ring, chain, collar oilers
- Pad - and waste-type devices
- Positive force feed lubricators
- Air oil devices
- Pressure circulating systems
- Centralized lubricating systems
- built-in-lubrication

Manual Devices

Lubricating methods may require human action in one form or another. The term manual lubrication applies to methods in which the operator is directly responsible for quantity of lubricant and interval of lubrication. Although
the initial cost of manual lubrication is low, the maintenance costs can be high. Reliability may be owing to considerable dependence on human action. The lubricant is quite prone in contamination. Generally speaking, manual lubrication is satisfactory only for lightly loaded or low speed bearings, typical applications include open gears, chains, wire rope, etc.

Drop-feed Devices:

Drop feed devices are gravity-flow lubricators. They are employed to deliver lubricant drop-by-drop to individual bearings and other machine elements. They give the best advantage when lubricant points are readily accessible.
Their cost is relatively low. Maintenance cost depends on type of service and location. Depending on the lubricator, lubricant flow may or may not be stopped and started automatically. Automatic operation increase reliability.
Typical service applications include journal and roller bearings, gears, chains, engine guides, pumps and compressors.

Splash or Bath Lubrication:

This type of lubrication is commonly used for machinery having high speed moving parts. These dip into oil and splash it on to the bearings or other machine elements. The splash system requires enclosing the mechanism to be lubricated. Initial cost of splash system depends on the expense incurred in enclosing the mechanism. Maintenance costs are low. A splash system is reliable, prevents contamination. Typical applications include internal-combustion engines, chain drives and enclosed gear sets.

Q 2 (a) (Necessity 2 marks & methods of purification 2 marks)

Water purification is the process of removing undesirable chemicals, biological contaminants, suspended solids and gases from contaminated water. The goal of this process is to produce water fit for a specific purpose. Most water is disinfected for human consumption (drinking water) but water purification may also be designed for a variety of other purposes, including meeting the requirements of medical, pharmacological, chemical and industrial applications.

In general the methods used include physical processes such as –

filtration,

sedimentation, and

distillation,

biological processes such as slow sand filters or biologically active carbon,

Chemical processes such as flocculation and chlorination and the use of electromagnetic radiation such as ultraviolet light.

Necessity : The purification process of water may reduce the concentration of particulate matter including suspended particles, parasites, bacteria, algae, viruses, fungi; and a range of dissolved and particulate material derived from the surfaces that water may have made contact with after falling as rain.

The standards for drinking water quality are typically set by governments or by international standards. These standards will typically set minimum and maximum concentrations of contaminants for the use that is to be made of the water.

b) **Importance of Maintenance**

The importance of plant maintenance varies with the type of plant and its production.

Equipment breakdown leads to an inevitable loss of production

An improperly maintained or neglected plant will sooner or later required expensive and frequent repairs, because with the passage of time all machines or other facilities such as transportation facilities, buildings etc wear out and need to be maintained to function properly

Plant maintenance plays a prominent role on production management because plant breakdown creates problems such as, Loss in production time, Rescheduling of production, Spoilt materials,

Failure to recover overheads, Need for over-time, Need for subcontracting WORK, Temporary work shortages-workers require alternative work.

c) **Wear Behaviour (4 marks)**

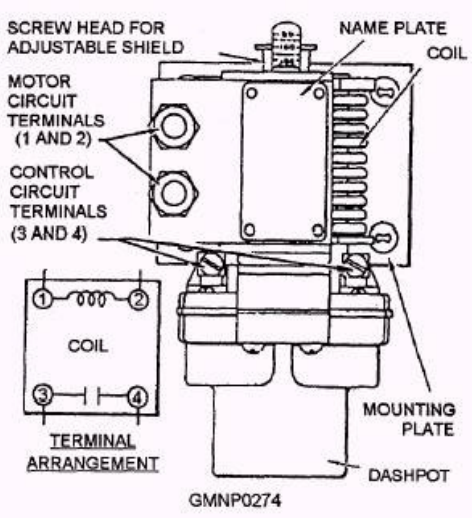
"Wear is the progressive loss of substance from the surface of a solid body caused by mechanical action, i.e , contact and relative motion with a solid, liquid or gaseous counter-body".

Wear resistance is not an intrinsic material property. Many industrialists hope for a wear test equivalent of the hardness or tensile test and it remains difficult for some to understand why this is not possible. Changes to surface and near surface structures during wear contact normally significantly alter local material properties, both mechanically and chemically and, between different wear situations, so many variables apply that direct wear performance comparisons are not possible. However, with controlled laboratory wear tests, specific comparisons can sometimes be made although results often have a qualified application to the modeled engineering situation.

For a given set of conditions, wear behavior is normally divided into two time based categories, "running in" and "steady state". During steady state, wear conditions are relatively stable and can be comparatively examined. During running in, conditions are far more complex and variable, eg., due to work hardening, surface chemistry changes, plastic deformation of asperities, material phase changes etc. Although wear rates are generally higher during running-in, this is not always the case.

d) Overload relay: (Sketch 2 marks & explanation 2 marks)

Electric motors need over current protection to prevent damage from over-loading the motor, or to protect against short circuits in connecting cables or internal faults in the motor windings.



The overload relay consists of a coil, a plunger, a dashpot, and a pair of switch contacts. The plunger is attached to a disk suspended in an oil-filled chamber (dashpot). The coil connects in series with an associated 440-volt motor supply circuit and the switch contacts are in a 115-volt start-and-run circuit for the motor.

During normal operation, the magnetic flux induced by the coil is not great enough to cause an appreciable movement of the plunger. However, if an overload of sufficient magnitude and duration occurs, the increased current through the coil draws the plunger upward.

When the plunger and disk reach the end of their upward travel, the normally closed contacts open in the 115-volt start-and-run circuit, de-energizing the motor contactor which opens the 440-volt motor supply circuit. With the motor circuit open, the overload relay plunger drops and the relay resets.

Since the dashpot retards upward movement of the plunger disk, the circuit does not break instantaneously during an overload. Two conditions determine the delay time: (1) the size of the orifice in the plunger disk through which the oil must pass and (2) the magnitude of the overload (strength of the magnetic field).

e) (Definition 1 mark, any six causes 3 marks)

An accident may be defined as 'an unplanned, uncontrolled and undesirable event or a sudden mishap which interrupts an activity or a function'

Causes of Accidents:

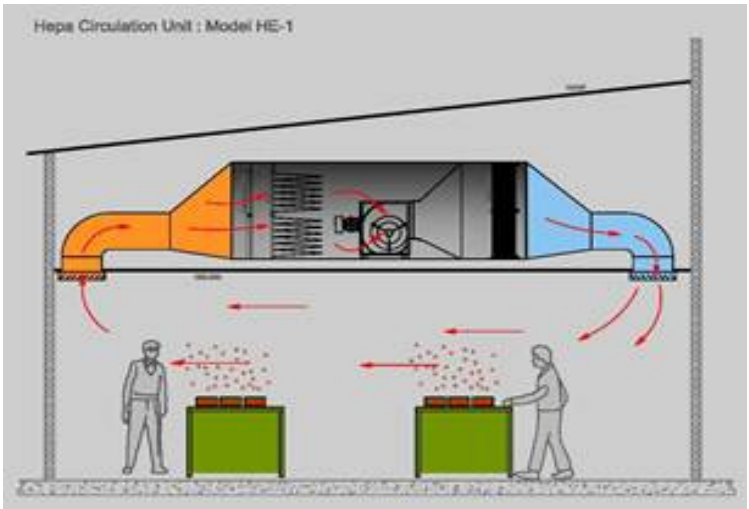
Following are the main reasons why accidents occur:

- Improper working conditions
- Poor quality of illumination
- Working methods
- Long hours of work
- Fatigue
- Immature age of workers
- Inexperience
- Bad state of health
- Unfavorable emotional and mental conditions
- Bad outlay of the work-place.
- Unsafe practices associated with the job
- Faulty equipments
- Lack of concentration in work
- Poor discipline
- Slippery floor
- Unguarded machines, Poor house-keeping, Irregular steps, etc

Q. 3 (a) Industrial Ventilation- Ventilation is considered an "engineering control" to remove or control contaminants released in indoor work environments. It is one of the preferred ways to control employee exposure to air contaminants. **(1 Mark)**

Necessity of a ventilation system

1. Provide a continuous supply of fresh outside air.
2. Maintain temperature and humidity at comfortable levels.
3. Reduce potential fire or explosion hazards.
4. Remove or dilute airborne contaminants. **(2 Marks)**



(any one sketch 1 Mark)

Q. 3 (b) Maintenance may be classified as (1 mark each)

1. **Corrective or Breakdown Maintenance** – It implies that repairs are made after equipment is out of order and it cannot perform its normal function any longer e.g. an electric motor will not start , a belt is broken.

2. **Scheduled Maintenance** – It is a stitch-in-time procedure aimed at avoiding breakdowns. It is generally followed for overhauling of machines, cleaning of water and other tanks etc.

3. **Preventive Maintenance** – It locates weak spots in all equipments, provides them regular inspection and minor repairs thereby reducing the danger of unanticipated breakdowns.

4. **Predictive Maintenance**- It makes use of human senses or other sensitive instruments such as audio gauges, vibration analyzers, amplitude meters etc. to predict troubles before equipment fails.

Q. 3 (c) Following are the eight pillars of TPM (Each for ½ mark)

1. Autonomous Maintenance- Maintaining basic conditions on shop floor and in machines.

2. Focused Improvement- Improvement is to eliminate production losses and reduce cost.

3. Planned Maintenance- It is carried out by Maintenance department and focus is on prevention.

4. Education & Training- Skill development for uniformity of work practices on machines.

5. Initial flow control- Developing machines for High Equipment Effectiveness.

6. Quality Maintenance- To develop perfect machine for perfect quality.

7. Office TPM- Offices oriented for excellent support for manufacturing. Improving office's Man-hour efficiency

8. Safety, Health and Environment- To achieve zero accidents, zero health hazards at work and to maintain zero pollution plant and environment.

Q. 3 (d) Following are the equipments needed for electrical maintenance with their functions (Any four)

1. **Lineman's Pliers:**
   Heavy duty pliers for general use in bending, cutting, crimping, pulling wire and twisting off tie wraps.
2. **Side Cutters:**
   Used to cut smaller gauged wires or to cut off tie wraps.
3. **Cable Cutters:**
   More powerful than regular pliers used to cut large conductors and smaller. Be sure to use these only on copper and aluminum. Also known as "eagle beaks".

4. **Crimping Pliers:**
   Used to install butt splices and stakons. Be sure to get a pair that has the insulated and non insulated option.
5. **Needle Nose Pliers:**
   Used for gripping in tight spaces, I find these work best when the pliers are rough at the end.
6. **Vice Grips:**
   Comes in handy as an extra support, especially when working alone.
7. **Wire Strippers:**
   Available in many different sizes, used to strip the insulation from the wire without damaging the wire as long as the proper size is selected.
8. **Hex Keys Metric:**
   Used to tighten electrical termination lugs.
9. **Electrician Scissors:**
   Used for cutting thick gauged wire.
10. **Tape Measure:**
    Used for measuring strut, conduit and tray and many other things. A 25 foot tape should be sufficient for any task.
11. **Crescent Wrench:**
    Handy when nut size isn't known, this specific wrench has a good set of jaws that won't lock up.
12. **Hack Saw:**
    Used to cut strut, conduit and cable.
13. **Torpedo Level:**
    Magnetized for convenience and accurate readings.
14. **Tin Snips:**
    Used to cut straight edge in sheet metal.
15. **Channel Locks:**
    Used to tighten conduit, conduit fittings, gang boxes and connectors, three different sizes is great to have.
16. **Wrench Set:**
    Speed wrenches are well worth it, most commonly used 7/16, 1/2, 9/16.
17. **Nut Drivers:**
    Used where a wrench can't, most common sizes 1/4-5/16- 7/16- 1/2- 9/16.
18. **Variable Screwdriver:**
    Used for various types of screws and terminals.
19. **Socket Set:**
    Most commonly used sizes are 3/8, 7/16, 1/2, 9/16
20. **Skinning Knife**
    Used to strip cable and insulation

Q. 3 (e) Necessity of safety policies in a plant: (Any four – 2 Marks)

(1) Provide workers with a safe work environment.

(2) Conduct routine/regular workplace inspections.

(3) Provide Personal Protective Equipment.

(4) Develop and implement safe work procedures and rules.

(5) Provide on-going safety training

(6) Enforce safety rules and appropriate discipline.

(7) Provide on-going property conservation practices.

Description of above any one policy in detail – (2 Marks)

Q. 4 (a) (i) Effect of lighting

It is important that lighting in the workplace**: (six points – ½ mark each)**

..

1. allows people to notice hazards and assess risks;
2. is suitable for the environment and the type of work (for example, it is not located against surfaces or materials that may be flammable);
3. provides sufficient light (illuminance on the task);
4. allows people to see properly and discriminate between colours, to promote safety;
5. does not cause glare, flicker or stroboscopic effects;
6. avoids the effects of veiling reflections;
7. does not result in excessive differences in illuminance within an area or between adjacent areas;
8. is suitable to meet the special needs of individuals;
9. does not pose a health and safety risk itself;
10. is suitably positioned so that it may be properly maintained or replaced, and disposed of to ensure safety;

Poor lighting can not only affect the health of people at work causing symptoms like eyestrain, migraine and headaches, but it is also linked to Sick Building Syndrome in new and refurbished buildings. Symptoms of this include headaches, lethargy, irritability and poor concentration**. (1 Mark)**

Q. 4 (a) (ii) Advantages of Preventive Maintenance over Break down maintenance (Any eight)

1. Reduced breakdowns and connected down-time.
2. Greater safety for workers.
3. Lesser odd-time repairs.
4. Low maintenance and repair costs.
5. Less stand-by or reserve equipments and spare parts
6. Lower unit cost of manufacture
7. Better product quality and fewer product rejects.
8. Increased equipment life
9. Fewer large scale and repetitive repairs.
10. Better industrial relations.

Q. 4 (a) (iii) TPM is a programme for fundamental improvement that involves the entire human resource. When implemented fully, TPM dramatically improves productivity and quality and reduces costs. An automation and labour saving equipment take production tasks away from humans, condition of production and office equipment increasingly affects output, quality, cost, delivery, health and safety, and employee morale.

TPM puts together a practical shop-floor system to prevent losses before they occur throughout the entire production system's life cycle: zero accidents, zero defects, zero breakdowns etc. All employees from top executive to front- line workers participate in TPM.

Q. 4 (a) (iv) Centralised Lubrication Systems :

Centralized Systems can be designed for oil or grease. A typical centralized system requires centrally located reservoir and pump, and permanently installed piping and distribution valves. These deliver measures quantities of lubricant at desired points. It can be either operated manually or automatically.

The piping and intricate dispensing valves make initial cost very high, but maintenance costs are very low. Initial cost is offset by dependability, durability, safety and resistance of system to contamination.

Centralized Systems are ideally suited for steel and paper mills, machine tools etc.

Q. 4 (b) (i)

Machine history card is one of the most required records that help to maintenance department of each machines details & its history to understand when machine was breakdown, why it was happen & what was done to repair, how much cost calculated for this particular maintenance on that machine.

This data will help for all the time to maintenance department people who having a MEMO (Internal request form for maintenance of machine) of machine. Maintenance people get the details when any MEMO get from any department and compare problems and solution which previously apply as result quick repairing, avoiding trial & error system and help to impact to other same machinery.

History of breakdown help to prepare schedule of preventive maintenance, consumed parts inspection or expands inspections with extra required criteria, re analysis on part if breaking again & again or breaking part due to others machine parts. Give training to repairers, maintenance officers, service operators, machine operators, electrical personal & helpers of machine if possible.

1. **PURPOSE:**

To establish & maintain the system for mechanical maintenance of equipments, to ensure that equipment are available continuously.

2. **SCOPE:**

This is applicable to the preventive & breakdown Maintenance of all mechanical equipments of Wheel Plant.

Q. 4 (b) (ii)

Mechanical controls regulate and control temperature, pressure and flow of fluid and oil in the system.

Oil Controls

- Keep refrigeration systems at peak performance at all times;
- Keep compressors lubricated;
- Maintain high level of heat transfer and energy efficiency;
- Remove as much oil as possible from the refrigerant.

Temperature Pressure Controls

- Provide control for compressor cycling, pump-down or defrost;
- Protect against loss of charge and freezing;
- Grant operators complete control of temperature pressure.

  A thermostat is a simple negative feedback controller: when the temperature (the "process variable" or PV) goes below a set point (SP), the heater is switched on. Another example could be a pressure switch on an air compressor: when the pressure (PV) drops below the threshold (SP), the pump is powered. Refrigerators and vacuum pumps contain similar mechanisms operating in reverse, but still providing negative feedback to correct errors.
- Simple on–off feedback control systems like these are cheap and effective. In some cases, like the simple compressor example, they may represent a good design choice.
- In most applications of on–off feedback control, some consideration needs to be given to other costs, such as wear and tear of control valves and perhaps other start-up costs when power is reapplied each time the PV drops. Therefore, practical on–off control systems are designed to include hysteresis: there is a dead band, a region around the set point value in which no control action occurs. The width of dead band may be adjustable or programmable.

Q. No. 5 Attempt any four of the following.

(4x4)

a) Basic Facilities in plant:

(02 Marks)

Drinking water

First aid

Seating and Facilities for rest

Lighting

Drinking water: (02 Marks)

An adequate supply of free, cool, wholesome drinking water is required. Water should be readily accessible to employees including, where necessary, provision for disabled workers. Except where the water is delivered in inclined upward jets from which workers can conveniently drink, suitable cups or drinking vessels are required at each point of supply, together with facilities for cleaning them. Drinking points should not be located in sanitary accommodation. Any appliance used to cool drinking water should be regularly inspected, tested and maintained so that it cannot in itself contaminate that water.

Where water unsafe for drinking is provided for use in industrial processes or for fire protection, effective precautions to ensure no human consumption are necessary. Precautions are required to ensure that drinking water supplies are not contaminated by any process or activity in the workplace.

b) Accessibility for maintenance:

Accessibility refers to the relative ease with which an assembly or component can be reached for repair, replacement, or servicing.

Maintenance work often involves using access equipment to reach roofs, gutters, building services, and raised sections of plant and machinery. It can be all too easy to fall from these positions, or to drop things onto people beneath.

The WAIT toolkit[1] provides advice and guidance on the suitability of the most common types of access equipment available. This will be particularly helpful if you aren't an expert in these matters and only use access equipment occasionally.

Do as much work as possible from the ground. Some practical examples include:

1. using extendable tools from ground level to remove the need to climb a ladder
2. installing cables at ground level
3. lowering a lighting mast to ground level
4. ground level assembly of edge protection

c) Benefits of TPM for plant maintenance:

TPM is a programme for fundamental improvement that involves the entire human resource. When implemented fully TPM dramatically improves productivity and quality and reduces costs. As automation and labor saving equipment take production tasks away from humans, condition of production and office equipment increasingly affects output, quality, cost, delivery, health and safety and employee morale. In a typical plant however many pieces of equipment are poorly maintained. Neglected equipment results in chronic losses and time wasted on finding and treating their causes.

Companies practicing TPM invariably achieve startling results, particularly in reducing equipment breakdowns, minimizing idling and minor stops (indispensable in unmanned plants), lessening quality defects and claims, boosting productivity, trimming labor and costs, shrinking inventory, cutting accidents, and promoting employee involvement.

For example, PQCDSM (Productivity, Quality, Cost, Delivery, Safety, Morale) improvements for early TPM implementers in Japan.

1. P – Productivity.

   Net productivity up by 1.5 to 2.0 times.

   Number of equipment breakdowns reduced by 1/10 to 1/250 of baseline.

   Overall plant effectiveness 1.5 to 2.0 times greater.

2. Q – Quality.

   Process defect rate reduced by 90%.

   Customer returns/claims reduced by 75%.

3. C – Cost: Production costs reduced by 30%.
4. D – Delivery: Finished goods and Work in Progress (WIP) reduced by half.
5. S – Safety.

   Elimination of shutdown accidents.

   Elimination of pollution incidents.
6. M – Morale: Employee improvement suggestions up by 5 to 10 times.

In addition to this, TPM has following intangible benefits.

After introduction of autonomous maintenance activity, operators can take care of machines by themselves without being ordered to.

With the achievement of zero breakdowns and zero defects, operators get new confidence in their own abilities.

Workplaces that used to be covered with oil and chips are now so clean and pleasant.

Improved image of the company, leads to the possibility of increased orders.

d) Wear:

Wear is defined as the action of causing deterioration through use. In materials science, wear is considered to be the erosion of material from a solid surface by the action of another solid.

Corrosive wear is the deterioration of useful properties in a material due to reactions with its environment.

Corrosive reactions wear process: Chemical reaction + Mechanical action = Corrosive wear

The fundamental cause of Corrosive reaction wear is a chemical reaction between the material and a corroding medium which can be a chemical reagent, reactive lubricant or even air. Understanding the mechanisms of corrosive is important to reduce this kind of wear. Let us consider a jaw coupling used for connecting shaft and motor. This coupling is corroded, due to moist environment and its outer dimensions have increased. If we rub this coupling with fingers, brown color debris will get detached from the coupling surface. In other words, after chemical reactions, mechanical action

is essential to initiate corrosive reaction wear.

Stages of corrosive wear:

- Sliding surfaces chemically interact with environment (humid/industrial vapor/acid)
- A reaction product (like oxide, chlorides, copper sulphide)
- Wearing away of reaction product film.

Sliding surfaces may wear by chemically reacting with the partner surface or the environment, or both. The oxide layers resulting from reactions with the environment are typically 10 microns thick, and they may have a protective role unless the thickness tends to grow during the cyclic contact process. If the oxide layer grows, it becomes liable to break in brittle fracture, producing wear particles. Hard, broken-off oxide particles may then profoundly affect subsequent wear life as abrasive agents. If soft, ductile debris results, it may form a protective layer on the surface.

e) Necessity of earthing for electrical installation:

Necessity:

1. To bring the body of electrical equipments to zero potential thus avoid the electric shock to human body.
2. To avoid the risk of fire due to earth leakage current through unwanted path.
3. To ensure that no current carrying conducting parts to zero with respect to the earth.

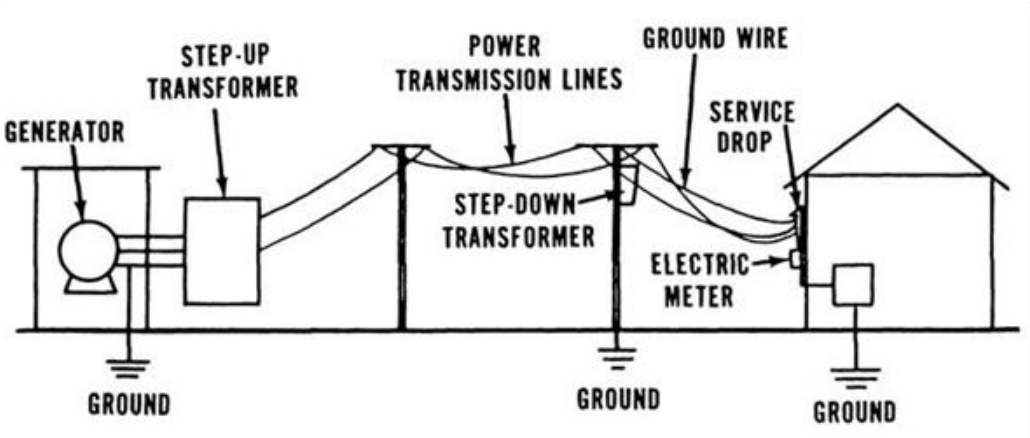
For example, if in case the insulation between the heating coil and metallic frame of the electric toaster fails, then heating coil directly comes in contact with the metallic body. Thus the metallic body will also behave like a live conductor. But due to connection of metallic body to the earth, will cause flow of large current to the earth causing blowing of fuse connected in phase wire. If the wire is not provided, then under this situation, metallic frame will be at the same voltage as the live wire. If a person accidentally comes in contact with the metal frame, then he will provide a path for the current from metallic frame to the earth. Thus he will get a severe shock. However when the earthing is provided

Q. No. 6 Attempt Any Two of the following.

a) Electrical power supply system:

An electric power system is a network of electrical components used to supply, transmit and use electric power. An example of an electric power system is the network that supplies a region's homes and industry with power - for sizable regions, this power system is known as the grid and can be broadly divided into the generators that supply the power, the transmission system that carries the power from the generating centres to the load centres and the distribution system that feeds the power to nearby homes and industries. Smaller power systems are also found in industry, hospitals, commercial buildings and homes. The majority of these systems rely upon three-phase AC power - the standard for large-scale power transmission and distribution across the modern world.

A schematic of a simple transmission/distribution system is shown in the adjoining figure which clearly shows the various steps involved transferring power from generation point to the point where it finally gets consumed. The main components such as generators, transformers and grounding are shown which will be discussed at later stages.



Electric power supply system

b) Describe fool proofing devices for interlocking

i) Parallel shafts

ii) Shafts at right angle

An interlock is a device used to prevent undesired states in a state machine, which in a general sense can include any electrical, electronic, or mechanical device or system. In most applications an interlock is used to help prevent a machine from harming its operator or

damaging itself by stopping the machine when tripped. Household microwave ovens are equipped with interlock switches which disable the magnetron if the door is opened. Similarly household washing machines will interrupt the spin cycle when the lid is open. Interlocks also serve as important safety devices in industrial settings, where they protect employees from devices such as robots, presses, and hammers.

Trapped key interlocking is a method of ensuring safety in industrial environments by forcing the operator through a predetermined sequence using a defined selection of keys, locks, switches and gears.

c) Enlist primary wear process and explain in details.

1. Adhesive wear
2. Abrasive wear
3. Surface fatigue
4. Fretting wear
5. Erosive wear

Adhesive wear:

Adhesive wear can be found between surfaces during frictional contact and generally refers to unwanted displacement and attachment of wear debris and material compounds from one surface to another. Two separate mechanisms operate between the surfaces.

Abrasive wear:

Abrasive wear occurs when a hard rough surface slides across a softer surface. ASTM International (formerly American Society for Testing and Materials) defines it as the loss of material due to hard particles or hard protuberances that are forced against and move along a solid surface.

Surface fatigue

Surface fatigue is a process by which the surface of a material is weakened by cyclic loading, which is one type of general material fatigue. Fatigue wear is produced when

the wear particles are detached by cyclic crack growth of micro cracks on the surface. These micro cracks are either superficial cracks or subsurface cracks.

Fretting wear:

Fretting wear is the repeated cyclical rubbing between two surfaces, which is known as fretting, over a period of time which will remove material from one or both surfaces in contact. It occurs typically in bearings, although most bearings have their surfaces hardened to resist the problem. Another problem occurs when cracks in either surface are created, known as fretting fatigue. It is the more serious of the two phenomena because it can lead to catastrophic failure of the bearing. An associated problem occurs when the small particles removed by wear are oxidised in air. The oxides are usually harder than the underlying metal, so wear accelerates as the harder particles abrade the metal surfaces further. Fretting corrosion acts in the same way, especially when water is present. Unprotected bearings on large structures like bridges can suffer serious degradation in behaviour, especially when salt is used during winter to deice the highways carried by the bridges.

Erosive wear:

Erosive wear can be described as an extremely short sliding motion and is executed within a short time interval. Erosive wear is caused by the impact of particles of solid or liquid against the surface of an object. The impacting particles gradually remove material from the surface through repeated deformations and cutting actions. It is a widely encountered mechanism in industry. A common example is the erosive wear associated with the movement of slurries through piping and pumping equipment.