

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 judgement 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.
- (note : check once again marking scheme for all questions. Insert page no. to all pages)**

Q1. A) Attempt any three.**a) Explain necessity of water purification in industry. Name various methods used.****Necessity:****(2 Marks)**

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.

Water purification methods can be classified in to three main categories**(2 Marks)**

- 1) Physical methods
- 2) Chemical methods
- 3) Biological methods
 - a. Physical methods are 1) screening 2) Grit Chambers 3) Absorption 4) Sedimentation 5) Flotation 6) Filtration 7) Heat transfer operation
 - b. Chemical methods are 1) Neutralization 2) Oxidation 3) Chlorination 4) Reduction 4) Ion exchange.
 - c. Biological methods are 1) Aerobic biological treatment 2) Anaerobic biological treatment

b) State importance of maintenance and name its types.**Importance of Maintenance****(2 Marks)**

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 require 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.

Types of Maintenance**(2 Marks)**

- 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.

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Model Answer

c) Write benefits of Total Productive Maintenance.

(Any 4 Pts 4 Marks)

- 1) Improvements in operational efficiency
- 2) Improvements in reliability
- 3) Improvements in quality
- 4) Lower operating cost
- 5) More emphasis on planning and preventative maintenance
- 6) Increased equipment life span
- 7) Higher morale from improved job satisfaction and job security
- 8) Improvements in inventory -cost reduction

d) Write factors affecting selection of lubricants.

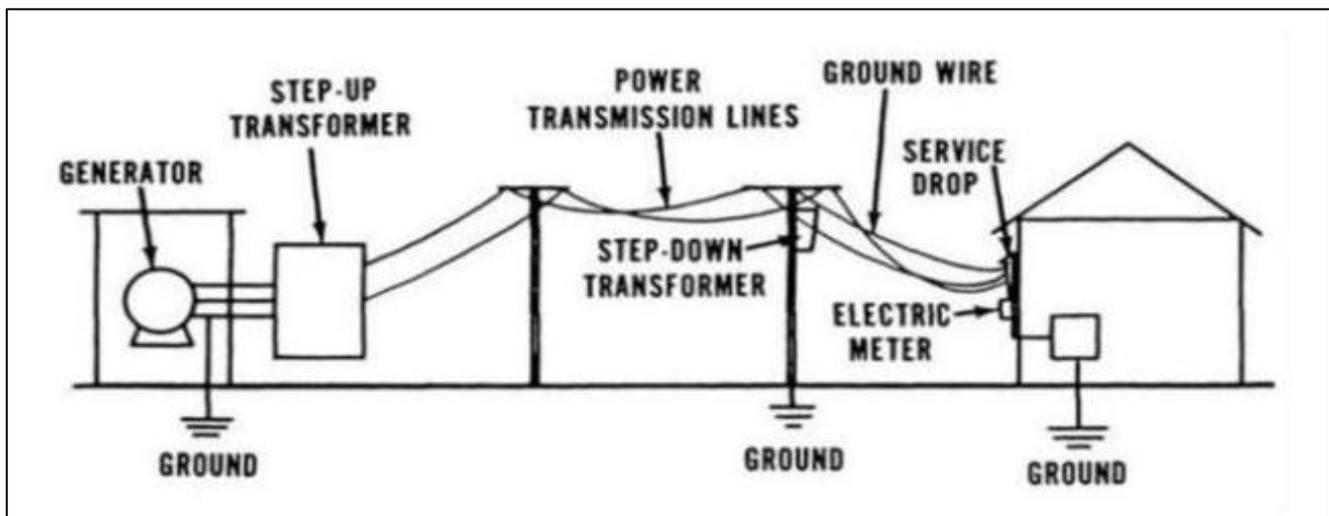
Factors affecting selection of lubricants

(Any 4 Pts 4 Marks)

- 1) Service temperature range
- 2) Speed factor
- 3) Hydrodynamic lubrication
- 4) Elasto-hydrodynamic lubrication
- 5) Extreme pressure
- 6) Emergency lubrication
- 7) Fretting
- 8) Design life
- 9) Acceptable re-lubrication intervals
- 10) Cost
- 11) Biodegradability

B) Attempt any one.

a) Sketch and explain electric power distribution system used in industry (Sketch 2, Explanation 4 Marks)



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.

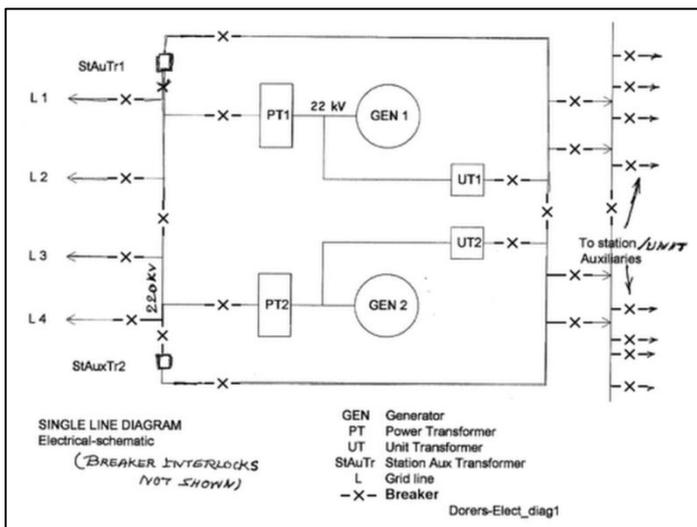
b) What is standby and emergency power? Explain the schemes used with sketch.

(Def. 2 Marks, Sketch with explanation 4 Marks)

Standby power- It is the electric power consumed by electronic and electrical appliances while they are switched off or in a standby mode. This only occurs because some devices claimed to be "switched off" on the electronic interface, but are in a different state from switching off at the plug, or disconnecting from the power point, which can solve the problem of standby power completely.

Emergency power - System is an independent source of electrical power that supports important electrical systems on loss of normal power supply. A standby power system may include a standby generator, batteries and other apparatus. Emergency power systems are installed to protect life and property from the consequences of loss of primary electric power supply.

Sketch with suitable explanation on schemes



Q2. Attempt any four.

a) What is repair cycle? State various activities performed in four stages of repair cycle.

Repair cycle----- (2 Marks)

The stages through which a reparable item passes from the time of its removal or replacement until it is reinstalled or placed in stock in a serviceable condition.

Activities performed in repair cycle. ----- (2 Marks)

1. Anticipation of maintenance work.
2. Visualization of nature and details of the work.
3. Determination of the best work for arranging the required material.
4. Securing alteration in production program or scheduling of maintenance work to confirm the production plan.
5. Allocation of work to individuals.
6. Instructing the individual about the follow-ups and checking of work.
7. Evaluation of work and performance

b) Write procedure of preventive maintenance for a compressor.

Procedure of preventive maintenance for a compressor (Correct Procedure 4 Marks)

- 1) Air filters should be inspected and cleaned weekly for best results. Many can be shaken out to remove dust and debris and they should be changed completely each month.
- 2) Oil should be checked weekly and changed as needed. Most compressors also have an oil filter that needs changed at regular intervals.
- 3) Inlet filters need inspected weekly and replaced as needed.
- 4) Piping and joints should be checked for air and water leaks. Most air leaks are easy to fix.

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Model Answer

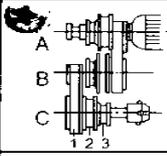
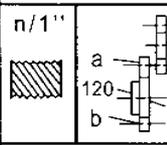
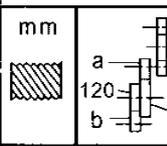
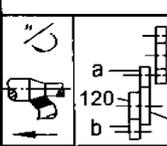
- 5) Compressors should be kept clean. Removing dirt and debris from the exterior of a unit helps keep the air filter clean.
- 6) Belts should be inspected weekly for wear and tension and replaced when necessary.

c) Compare breakdown v/s preventive maintenance (Any 4 points 4 marks)

1. A relationship exists between the amount of preventive maintenance which has to be performed and the amount of breakdown maintenance which is required. Increase in preventive maintenance can be accepted to reduce the frequency for breakdown maintenance.
2. The component which is not replaced or repaired for preventive maintenance reasons then it eventually malfunctions and damages other component of the machine. This increases frequency and the cost of breakdown maintenance.
3. Breakdown maintenance cannot be planned and scheduled as systematically and efficiently as preventive maintenance.
4. Preventive maintenance is planned activity analysis knows when it will take place and how much time is required and what resources are required for its implementation.
5. When the cost of preventive maintenance increases the cost of breakdown decreases but after certain limit increases in expenditure on preventive maintenance becomes uneconomical. For which an optimum point can be determined.

**d) Draw a format for typical machine history chart and explain
Format for typical machine history chart**

(2 Marks)

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a	40	a	60	30	8	9	9.5	10	11	11.5	12	13	14
b	80	b	30	30	16	18	19	20	22	23	24	26	28
120	40		30	60	32	36	38	40	44	46	48	52	56
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a	40	a	30	28	30	30	30	30	30	42	60	60	60
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Explanation:

(2 Marks)

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, reanalysis 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.

c) Explain basic systems of Total Productive Maintenance.

(Explanation 4 Marks)

TPM is a system of maintaining and improving the integrity of production and quality systems through the machines, equipment, processes, and employees that add business value to an organization. TPM was first applied by the Japanese company Nippondenso, a supplier to the automotive industry. One of the main objectives of TPM is to increase the productivity of plant and equipment with a modest investment in maintenance. Total quality management (TQM) and total productive maintenance (TPM) are considered as the key operational activities of the quality managementsystem. TPM employs Breakdown maintenance, Preventive maintenance, Predictive maintenance and Corrective maintenance as its tools. TPM results in Improved operational efficiency and reliability. Thus the important features of TPM in brief are as below:

- 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.

Q3. Attempt any four of the following

a) What are pillars of Total Productive Maintenance?

Following are the eight pillars of TPM

(Each for ½ marks)

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.

b) What is wear? Compare adhesive wear with abrasive wear.

Wear-

(2 Marks)

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.

Adhesive wear vs abrasive wear

(2 Marks)

Adhesive wear:

Surface roughness also contributes to adhesion. For this type of wear a material's compatibility will be important. Compatibility does not mean materials that work well together; rather, that the materials "like" each other, causing them to stick together. This compatibility forms a bond causing parts to seize and even become cold-welded together. There are a few general rules to follow for material selection to make sure unwanted adhesive wear doesn't occur. Materials that make contact with one another, in general, should:

- Not dissolve in the other
- Not, in given environment and other conditions, form into an alloy
- Not be identical (e.g., an aluminium shaft with an aluminium bearing)
- Have at least one metal from the B-subgroup (e.g., elements to the right of Nickel, Palladium, and Platinum on the periodic table).

Adhesion is possible to calculate. The adhesion and abrasive wear calculations share the same formula; however, it can vary by as much as +/-20%. This inaccuracy is due to constant changing surface conditions and lubrication during operation. It may be better than no data, but designers need to be aware of the limitations and accuracy of the formula. Trying to calculate or predict wear is made more difficult if components have non-conforming geometries, such as when gear teeth and cams are involved. These

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Model Answer

components can have difficulty staying properly lubricated. To reduce adhesive wear, sometimes corrosive wear is purposely induced.

Abrasive wear:

There are two common types: two-body and three-body abrasion. Two-body abrasion refers to surfaces that slide across each other where the one (hard) material will dig in and remove some of the other (soft) material. An example of two-body abrasion is using a file to shape a workpiece. Three-body abrasion is where particles between the two surfaces remove material from one or both surfaces. The tumbling process is an example of this.

Tumbling involves using particles to sand and polish the surface of a part. The particles that cause abrasion are often called contaminants. Contaminants are anything that enters a system that creates abrasion. While lubrication is imperative, an active lubrication system can introduce contaminants that cause abrasion. Filters remove contaminants and are one of the reasons proper maintenance and replacement of filters is important. However, the lubrication, or the additives in it, can react with the metal, creating a thin monolayer of contaminants that also make proper lubrication selection important to reduce wear to your equipment.

Surface roughness is another important variable for wear. Two-body abrasion is reduced by having smoother surface roughness. For example, a journal or sleeve bearing made out of a softer material will slide against a harder drive shaft with little to no abrasion due to the surface finish. Using materials with similar hardness is generally not advised. The reason for the softer bearing material is to further reduce wear. Contaminants can become embedded into the softer materials and stop three-body abrasion from occurring. This technique might damage the bearing, but is preferred as it is designed to be relatively easy and more cost-effective to replace than a drive shaft. The rougher surfaces can increase the coefficient of friction and micro-peaks can break off, contributing to contaminants that are related to abrasion.

c) State conditions in which following lubrication systems are suitable (Correct Examples 4 Marks)

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

ii) Pad- Suitable for Ideal small to medium size blanks, rectangular or shaped

iii) Splash - It is widely used in small four-cycle engines for lawn mowers, outboard marine operation

iv) Wick – Oil lamp

d) Explain maintenance job responsibility allocation Process used in Total Productive Maintenance.**(Explanation 4 Marks)**

- 1) To begin applying TPM concepts to plant maintenance activities, the entire work force must first be convinced that upper level management is committed to the program.
- 2) The first step in this effort is to either hire or appoint a TPM coordinator. It is the responsibility of the coordinator to sell the TPM concepts to the work force through an educational program. To do a thorough job of educating and convincing the work force that TPM is just not another "program of the month," will take time, perhaps a year or more.
- 3) Once the coordinator is convinced that the work force is sold on the TPM program and that they understand it and its implications, the first study and action teams are formed.
- 4) These teams are usually made up of people who directly have an impact on the problem being addressed. Operators, maintenance personnel, shift supervisors, schedulers, and upper management might all be included on a team.
- 5) Each person becomes a "stakeholder" in the process and is encouraged to do his or her best to contribute to the success of the team effort.
- 6) Usually, the TPM coordinator heads the teams until others become familiar with the process and natural team leaders emerge.
- 7) A long-range outlook must be accepted as TPM may take a year or more to implement and is an on-going process. Changes in employee mind-set toward their job responsibilities must take place as well.

e) Explain observed wear behaviour due to primary wear process.

Wear behaviour due to primary wear process

(Explanation 4 Marks)

Wear- It is the removal and deformation of material on a surface as a result of mechanical action of the opposite surface. Primary stage or early run-in period, where surfaces adapt to each other and the wear-rate might vary between high and low.

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, 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.

Q4. Attempt any Three.

a) State the meaning of accessibility. For maintenance on which factors it depends?

Answer:-

Accessibility refers to the relative ease with which an assembly or component can be reached for repair, replacement, or servicing. **(2 Marks)**

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.

Factors affecting accessibility:

(2 Marks)

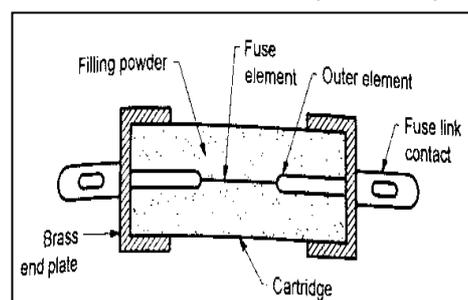
- 1) Maintenance complexity
- 2) Space availability
- 3) Nearness of part
- 4) Part size and shape
- 5) Way to reach maintenance part
- 6) Tooling availability

b) Explain construction of circuit breaker and its use.

Construction: - Circuit breaker are mechanical devices designed to close or open contact members, thus closing or opening of an electrical circuit under normal or abnormal conditions. High rupturing capacity fuses mainly consists of a heat resisting ceramic body. Both ends of the ceramic body may consist of metal end caps. A silver current carrying element is welded to these metal end caps. The current carrying element is completely surrounded by the filling powder. The filling material may be plaster of parries, chalk, quartz or marble dust. Filling material may act as an arc quenching and cooling medium when fuse elements blows off due to excessive heat generated under abnormal conditions. ----- **(2 Marks)**

Use:- ----- **(2 Marks)**

- 1) Interruption of small inductive currents
- 2) Switching of unloaded transmission lines and unloaded cables
- 3) Switching of capacitor banks
- 4) Interruption of terminal banks
- 5) Interruption of short line faults
- 6) Asynchronous switching



c) Explain necessary steps / precautions for preventions of fire due to electricity**(1 Mark each for any 4 correct points)**

- 1) The most important factor to avoid fire due to electrical reasons is to use proper rating of fuses and protective relays in the circuit, which should depend upon the connected load on the circuit.
- 2) Indian electricity rules should be followed. The load on any circuit should not exceed beyond permissible limit and also the rating of wires should be in accordance with the load connected. No circuit should at any time be overloaded.
- 3) A very good earth should be provided to equipment or machinery so that if at all earth fault takes place, very large momentary current should flow to the earth causing melting of fuse immediately or operation of earth fault relay.
- 4) The insulation provided on the connecting wires should be of very good quality and it should withstand
- 5) Other material used for providing connections should also be of very good quality.
- 6) All joints of wires should be mechanically strong
- 7) Electrical insulation should be free from moisture
- 8) Fire fighting equipment's such as fire extinguisher, buckets filled with sand etc.

d) What are personal protective equipment? Explain any two and their use.**(List 2 Marks, Description 2 marks)**

1. Respiratory protection - for example, disposable, cartridge, air line, half or full face.
2. Eye protection – for example, spectacles/goggles, shields, visors.
3. Hearing protection – for example, ear muffs and plugs.
4. Hand protection – for example, gloves and barrier creams.
5. Foot protection – for example, shoes/boots.
6. Head protection – for example, helmets, caps, hoods, and hats.
7. Working from heights - for example, harness and fall arrest devices.
8. Skin protection – for example, hats, sunburn cream, long sleeved clothes.

Foot Protection: Safety boots and shoes with protective toecaps and penetration-resistant, mid-sole wellington boots and specific footwear, e.g. foundry boots and chainsaw boots.

- Footwear can have a variety of sole patterns and materials to help prevent slips in different conditions, including oil- or chemical-resistant soles. It can also be anti-static, electrically conductive or thermally insulating
- Appropriate footwear should be selected for the risks identified.

Ears protection:

Hazards: Noise – a combination of sound level and duration of exposure, very high-level sounds are a hazard even with short duration

Options: Earplugs, earmuffs, semi-insert/canal caps

e) Write philosophy of TPM and its concept.**(4 marks for correct explanation)**

TPM is a system of maintaining and improving the integrity of production and **quality** systems through the machines, equipment, processes, and employees that add business value to an organization.

TPM is the methodology designed to ensure that every machine in a production process always performs its required risk and its output rate is never disrupted. In today's manufacturing environment employing high technical expensive machine back to back computer control and advance manufacturing concept, there is virtually no chance for breakdown of any type. The maintenance management aims zero breakdowns further more starting conventional repair of machines maintenance now has reached a stage of total productivity maintenance, a concept which aims at zero downtime.

TPM implementation means

- Total employee involvement
- Total equipment effectiveness.
- Total maintenance delivery system.

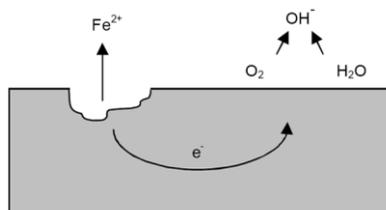
The crux of TPM is that a production equipment operators share the preventive maintenance efforts, assist machines with repairs when equipment is down and together they work on equipment and crosses improvement in team activities. TPM maximizes overall effectiveness of production system, prevents all kinds of losses, implemented by all departments. TPM involves every employee, motivates team work, appreciates team work.

B) Attempt any TWO

a) Explain corrosive reaction and pitting corrosion with examples. How these can be avoided?

Corrosive action is the gradual destruction of materials (usually metals) by chemical reaction with their environment. **Corrosion** is a natural process, which converts a refined metal to a more stable form, such as its oxide, hydroxide, or sulfide. **(1 Mark)**

Pitting corrosion, or **pitting**, is a form of extremely localized corrosion that leads to the creation of small holes in the metal. The driving power for pitting corrosion is the de-passivation of a small area, which becomes anodic while an unknown but potentially vast area becomes cathodic, leading to very localized galvanic corrosion. The corrosion penetrates the mass of the metal, with limited diffusion of ions. **(2 Marks)**



(1 Mark)

Examples:- a water droplet on the surface of a steel and pitting can initiate at the anodic site (centre of the water droplet). **(1 Mark)**

Corrosion Prevention:-

- 1) Proper selection of materials with known resistance to the service environment
- 2) Control pH, chloride concentration and temperature
- 3) Cathodic protection and/or Anodic Protection
- 4) Use higher alloys (ASTM G48) for increased resistance to pitting corrosion

(1 Mark)

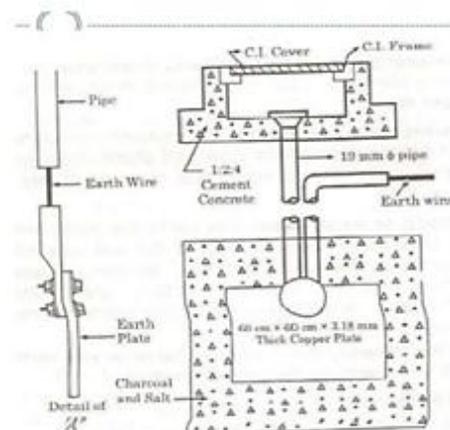
b) Explain procedure of earthing in electrical system. Write precautionary measures against electric shock.

Answer: The important methods of earthing are the plate earthing and the pipe earthing. The earth resistance for copper wire is 1 ohm and that of G I wire less than 3 ohms. The earth resistance should be kept as low as possible so that the neutral of any electrical system, which is earthed, is maintained almost at the earth potential. The typical value of the earth resistance at powerhouse is 0.5 ohm and that at substation is 1 ohm.

1. **Plate earthing**
2. **Pipe earthing**

Plate Earthing

In this method a copper plate of 60cm x 60cm x 3.18cm or a GI plate of the size 60cm x 60cm x 6.35cm is used for earthing. The plate is placed vertically down inside the ground at a depth of 3m and is embedded in alternate layers of coal and salt for a thickness of cm. In addition, water is poured for keeping the earth electrode resistance value well below a maximum of 5 ohms. The earth wire is securely bolted to the earth plate. A cement masonry chamber is built with a cast iron cover for easy regular maintenance.



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(2 Marks for explanation and 1 mark for diagram)

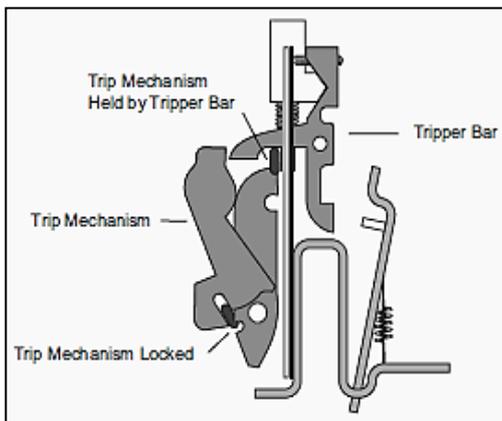
Precautionary Measures against Electric Shock:-

1. All electrical equipments are connected with good quality wires.
2. Before replacing a blown out fuse always put the main switch off.
3. Always keep the earth connection in good condition
4. Before using portable electrical things like table fan, iron box, heaters etc, see that these are well earthed.
5. Line wires should always be connected through the switch.
6. Replace immediately broken or damaged switches and plugs etc.
7. A plug point should never be disconnected by pulling the flexible cable.
8. Plug point connections should be made only by plug tops not by bare wires.
9. Check proper working of safety devices
10. Keep proper condition of electrical hand tools. **(3 Marks for any 6 correct points)**

Q5 Attempt any FOUR

a) Explain lever controlled trip mechanism with sketch.

Answer:- The trip unit includes a trip mechanism that is held in place by the tripper bar. As long as the tripper bar holds the trip mechanism, the mechanism remains firmly locked in place.



The operating mechanism is held in the “ON” position by the trip mechanism. When a trip is activated, the trip mechanism releases the operating mechanism, which opens the contacts. Thermal-magnetic circuit breakers employ a bi-metallic strip to sense overload conditions. When sufficient over current flows through the circuit breaker’s current path, heat builds up causes the bi-metallic strip to bend. After bending a predetermined distance, the bi-metallic strip makes contact with the tripper bar activating the trip mechanism.

(2 Mark for figure and 2 Marks for correct explanation)

b) Define electric accident. Write its causes and effects.

Electric accidents can be defines as a case where a person receives directly or indirectly either from a generating system, transmission system or distribution system of electric supply.

(2 marks for correct definition)

Causes:-

- 1) If person touches live wire or current carrying parts knowing or unknowingly
- 2) If the metal frame of the machine or equipment which has become live due to some fault is touched
- 3) If a high voltage winding in a transformer, shorts to its low voltage winding which may puncture insulation between LV and core
- 4) It may also take place when the fault develops electric spark or arcs and also when parts of electrical equipment become overheated.

(1/2 mark each for any 2 correct points)

Effects:

- 1) Partial disability
- 2) Complete disability
- 3) Life hazards
- 4) Machine breakdowns
- 5) Loss of machinery equipment’s
- 6) Personal injury
- 7) Loss of working hours
- 8) Reduction of working efficiency

(1 mark for any 2 correct points)

C) Explain fool proofing devices for interlocking (4 marks for correct explanation)

- 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.

d) State importance of lubrication

Answer:

1. To reduce friction Lubrication reduces friction between the moving parts to a minimum level, thereby minimising power loss.

2. To reduce wear Engine parts undergo wear during its operation. The wearing of moving parts is reduced due to lubrication.

3. To provide cooling effect When lubricating oil circulates the engine, it takes away heat from the moving parts. This heat is delivered to the surrounding air through the crankcase.

4. To provide cleaning action The lubricating oil dissolves many impurities like carbon particles during its circulation. This oil is purified by allowing it to pass through filters.

5. To provide cushioning effect Combustion of fuel in the combustion chamber gives rise to a sudden pressure inside the cylinder. This sudden increase in pressure produces shock which travels through the piston, piston pin and connecting rod. The lubricating oil film absorbs this shock at the main bearings thereby providing a cushioning effect.

6. To provide sealing The high pressure gases inside the cylinder may leak out towards the side of the crankcase. This leakage of gases is prevented by the lubricating oil which acts as an effective seal.

(1 mark each for any 4 correct points)

e) Explain the use of voltmeter and multimeter in electrical maintenance.

Answer:- Voltmeter

(2 Marks)

A **voltmeter** is an instrument used for measuring electrical potential difference between two points in an electric circuit. Analog voltmeters move a pointer across a scale in proportion to the voltage of the circuit; digital voltmeters give a numerical display of voltage by use of an analog to digital converter.

Voltmeters are made in a wide range of styles. Instruments permanently mounted in a panel are used to monitor generators or other fixed apparatus. Portable instruments, usually equipped to also measure current and resistance in the form of a multimeter, are standard test instruments used in electrical and electronics work. Any measurement that can be converted to a voltage can be displayed on a meter that is suitably calibrated; for example, pressure, temperature, flow or level in a chemical process plant.

Multimeter: Multimeter can be useful in the following electrical maintenance activities

- 1) To measure the AC and DC voltage
- 2) To measure current To measure resistance
- 3) To test continuity of circuit
- 4) Testing of diode

5) Testing of transistor

(2 Marks)

Q5. Attempt any FOUR.

a) Explain industrial ventilation system along with its importance.

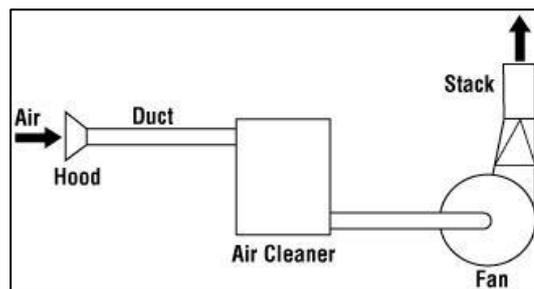
Answer:

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. (2 Marks)

There are two types of mechanical ventilation systems used in industrial settings:

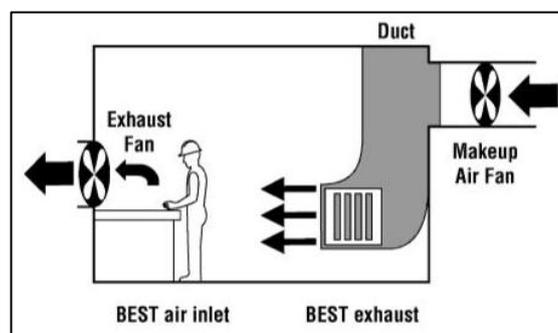
1. **Dilution** (or general) ventilation reduces the concentration of the contaminant by mixing the contaminated air with clean, uncontaminated air.
2. **Local exhaust** ventilation captures contaminants at or very near the source and exhausts them outside.

Dilution ventilation can include a few methods, from allowing in fresh air by opening doors and windows to using large fans. The point of such industrial ventilation systems is to direct the air away from the employees so they do not have to breathe contaminated air while working. Some of the benefits of this type include easy installation in most cases, typically little maintenance, and efficiency in controlling small sources of contaminants. Drawbacks of this kind of industrial ventilation are mainly related to the fact that it cannot typically handle large amounts of toxic chemicals or vapours that may pollute the air. A common example of dilution ventilation includes large commercial fans.



(2 Marks)

Local exhaust ventilation is a kind of industrial ventilation system that aims to stop contaminants before they spread. Unlike dilution ventilation, this type does not rely on fans to disperse the air. Rather, it works similarly to a vacuum, usually resulting in low concentration of the pollutants. It is often best suited for very toxic chemicals or a high amount of dust or fumes. While local exhaust ventilation is usually quite effective and energy-efficient, it typically costs more to install than dilution ventilation and is known by many for being a high-maintenance system. (2 Marks)



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)

b) Explain the following

i) Planning and scheduling of maintenance

(4 Marks for correct Explanation)

Ans: Planning decides what, how and time estimate for a job. Scheduling decides when and who will do the job. Planning of a job should be done before Scheduling a job.

Maintenance planning is the process in which maintenance work is documented, resources are assigned, work and safety procedures are identified, labor and materials are identified, and they are all interfaced with the scheduling element.

Maintenance scheduling is the process in which all resources which are required for work are scheduled for execution within a specified time frame. Executing this component requires an understanding of equipment/asset availability as well as technician, material, and specialty tool availability.

ii) Maintenance manuals and reports

Ans: **Maintenance Manuals:-**

(2 Marks)

When customer purchases new product manufacturer provides service or maintenance booklet which is called as maintenance manuals.

It provides information about assembly and part drawing of product, technical information about assembly and product, maintenance schedule with respect to time scale for product. Standardize maintenance procedure is provided by manufacturer. Maintenance check and care points are noted in the manual.

Maintenance reports:-

The maintenance data is recorded in the tabular formats which are called as maintenance reports. The maintenance engineering departments are responsible for all the data and activities mentioned in the reports.

It is necessary to maintain the reports for the following reasons,

- 1) For preparing maintenance schedule
- 2) Equipment replacements analysis
- 3) Use of these documents for improvement as well as to get history of maintenance
- 4) To determine frequency of inspection and maintenance
- 5) Budgeting for major overhauls.

(2 Marks)

C) Explain the following

i) First aid and its importance

Answer: - **First aid:**

First aid is the initial assistance given to a victim of injury or illness. Comprised of relatively simple techniques that can be performed with rudimentary equipment, first aid is usually carried out by a layperson until professional medical assistance arrives.

(2 Marks)

Importance of First aid:

- 1) It affords people with the ability to provide help during various emergency situations.
- 2) First aid helps ensure that the right methods of administering medical assistance are provided
- 3) Knowledge in first aid also benefits the individuals themselves. Whether the emergency affects themselves directly, or involves people they live and work with, first aid stems the severity of an emergency in a given time and place.

(2 Marks)

ii) Travel control by limit switches

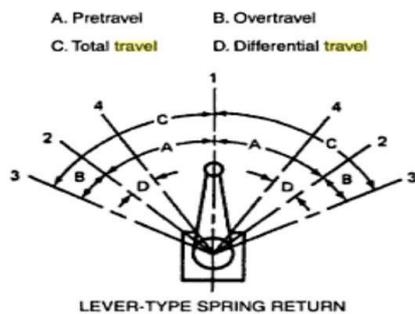
Answer:

Limit switches are used in a variety of applications and environments because of their ruggedness, ease of installation, and reliability of operation. They can determine the presence or absence, passing, positioning, and end of travel of an object. They were first used to define the limit of travel of an object; hence the name "Limit Switch".

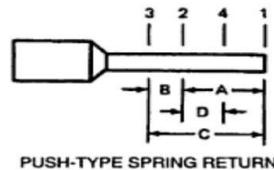
A second important factor is the type of mechanical action available to operate the switch. Here the operator is the major decision. Length of travel, speed, force available, accuracy, and type of mounting possible are some of the considerations.

In discussing the action of limit switches, specific terms are used. A knowledge of these terms is helpful:

- *Operating force*—the amount of force applied to the switch to cause the “snap over” of the contacts
- *Release force*—the amount of force still applied to the switch plunger at the instant of “snap back” of the contacts to the unoperated condition
- *Pretravel or trip travel*—the distance traveled in moving the plunger from its free or unoperated position to the operated position
- *Overtravel*—the distance beyond operating position to the safe limit of travel; usually expressed as a minimum value
- *Differential travel*—the actuator travel from the point where the contacts snap over to the point where they snap back
- *Total travel*—the sum of the trip travel and the overtravel



1. Actuator — free position
2. Actuator — operating position
3. Overtravel — limit position
4. Actuator — release position



(2 Marks for explanation and 2 marks for detail figure)