WINTER – 15 EXAMINATION

Subject Code:17531**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 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.

Q 1. A) Attempt any three:

a) Enlist methods of purification of water: (4 marks for description)

Ans.:--water purification methods can be classified in to three main categories

1) Physical methods

2) Chemical methods

3) Biological methods

- Physical methods are1) screening 2) Grit Chambers 3) Absorption 4) Sedimentation 5) Flotation 6) Filtration7) Heat transfer operation
- Chemical methods are1) Neutralization 2) Oxidation 3) Chlorination 4) Reduction 4) Ion exchange.
- Biological methods are 1) Aerobic biological treatment 2) Anaerobic biological treatment

b) State the importance of plant maintenance. (Any four points 1 mark each) (1 X4=4)

Maintenance is responsible for the smooth &efficient working of an Industry, and helps in improving productivity the main objectives of maintenance are as follows

1) Minimum break down time: Down time cost is made up of loss of production, wage payment for idle time, Depreciation of machine, Reduction in sale, etc.

2) Utilization of optimum capacity

3) To keep life of the equipment

4) To modify the machine tool

5) Economy

6) Ensure safety

7) Improve productivity

8) Maintain quality of product

c) State any four objectives of T P M (Any four points 1 mark each) (1 X4=4)

Following are the objectives of T P M

1) TPM aims to change corporate culture in order to maximize overall effectiveness of the productionssystems.

2)To prevent all kind of losses (zero defects, zero accidents, zero break down etc.)

3) T P M is implemented in all departments

4)T P M involves every employee, from Top management to workers on the shop floor.

d) State the various types of lubricants. (4 marks for description)

Lubricants are mainly classified in to three classes. 1) Liquid lubricants 2) Solid Lubricants 3) Semi solid & Gaseous lubricant.

1) **Liquid lubricants:** mineral oils and fatty oils

- Mineral oil: these are obtained by fractional distillation of petroleum they are not affected by high pressure, steam or alkalis. They are quite cheap extensively used as engineering machine lubricants.
- Fatty oils: they are vegetable oils and likely to decompose in heat and produce acid and crude iron, steel etc.there adhesiveness is greater.

2)**Solid lubricant:** graphite, talc, mica, whiteleads are the common used solid lubricants. They are mixed with semi solid lubricant and the mixture is supplied separately to the bearings which are lubricated with oil.

3) **Semi solid lubricant:** They don't flow at ordinary temperature. They are made from mineral oils and fatty oils known as grease. Thickness of grease is dependent on percentage of soap used. Graphite or powdered mica is sometimes added to grease so as to increase the lubricant quality. Grease is used on gear teeth wheel, bearing of rail road car, trucks, automobile etc.

B) Attempt any one:

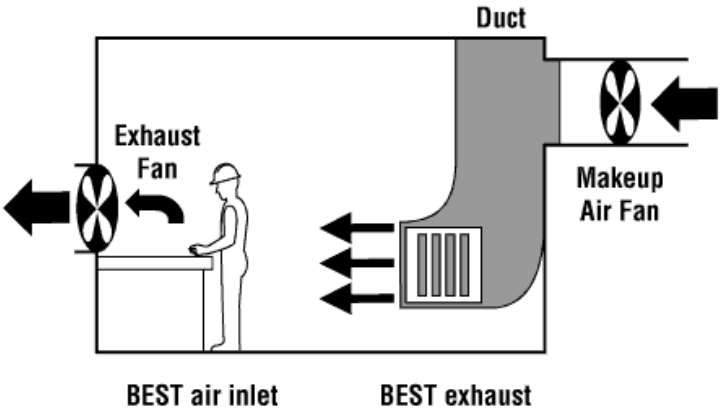
a) Describe working of industrial ventilation system with neat sketches. (3-sketch & 3-description) (6 marks)

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

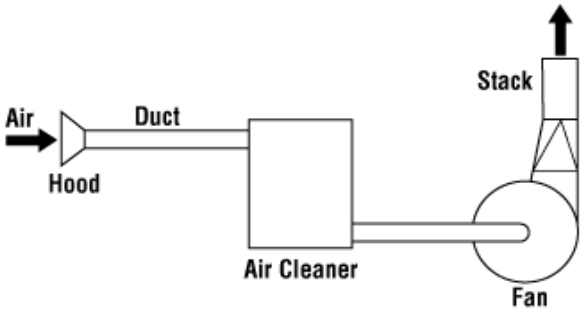
1. **Dilution** (or general) ventilation reduces the concentration of the contaminant by mixing the contaminated air with clean, uncontaminated air.

2. **Local exhaust** ventilation captures contaminates 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 whiling 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.



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.



b) Water distribution system with neat sketch: (3-sketch & 3-description) (6 marks)

Distribution system is a network of pipelines that distribute water to the consumers.

- They are designed to adequately satisfy the water requirement for a combination of

  - Domestic
  - Commercial
  - Industrial
  - Fire fighting purposes.

  DISTRIBUTION SYSTEMS

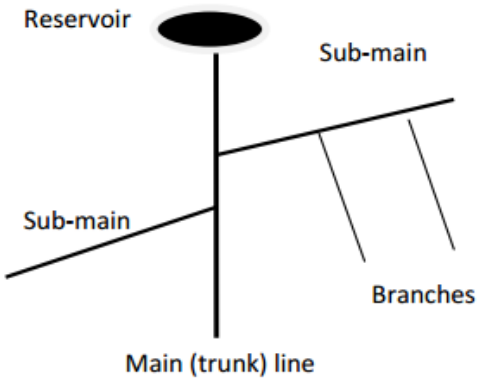
1. Branching pattern with dead end.
2. Grid pattern
3. Grid pattern with loop.

A) Branching pattern with dead end.

• Similar to the branching of a tree.

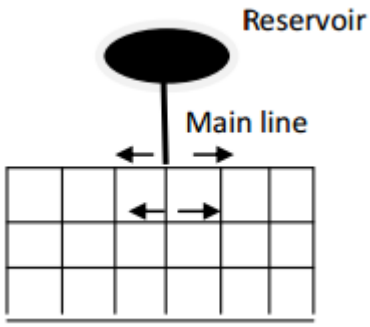
It consists of o Main (trunk) line o Sub-mains o Branches

• Main line is the main source of water supply. There is no water distribution to consumers from trunk line. • Sub-mains are connected to the main line and they are along the main roads. • Branches are connected to the sub-mains and they are along the streets. • Lastly service connections are given to the consumers from branches.



B) Grid pattern

• In grid pattern, all the pipes are interconnected with no dead-ends. In such a system, water can reach any point from more than one direction.



C) Grid Pattern with Loops is provided in a grid pattern to improve water pressure in portions of a city (industrial, business and commercial areas). Loops should be strategically located so that as the city develops the water pressure should be sustained. The advantages and disadvantages of this pattern are the same as those of the grid pattern.

Q2. Attempt any four:

a) Compare preventive maintenance and breakdown 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.

b) Predictive maintenance with example: (2 description & 2-example) (4 marks)

It is comparatively newer maintenance technique.

It makes use of human senses for other sensitive instruments .for e.g.

1. Audio gauges.
2. Vibration analyzer.
3. Amplitude meters.
4. Strain gauges etc.

To predict the troubles before the equipment fails. Example is as follows.

1. Unusual sound coming out of rotating equipment predict a trouble.
2. Electric cable excessive hot at a point predicts a trouble.
3. Simple hand touch can point out many unusual conditions and thus predict a trouble.

c) Repair cycle with example:(2 description & 2-example) (4 marks)

Following steps are involved;

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.

Purposed example.

Types of schedule	Activities	Sources of information
Long term	• Lubrication • Inspection • Overhauling • Cleaning • Replacementof machine	• Manufacturer's recommendation.eg. servicingof automobiles. • Technical experience. • History of machine • Analysis of life span • Techno-economic evaluation.

Short term	• Repairs • Replacement	• Inspection report • Complaint of breakdown.

d) Reasons of breakdown of machine tools.(Any four points 1 mark each) (4 marks)

Typical causes of breakdown of machine tool are as follows.

- Failure to replace worn out parts.
- Lack of lubrication.
- Neglected cooling system.
- Indifference towards minor faults.
- External factors like: wrong fuel, high line voltage i.e to low or high voltage.
- Indifference towards equipment vibration, unusual sound coming out of machinery.
- Equipment getting to much heated.

d) Basic system of TPM: (4 marks fordescription)

Intoday'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.

Q3 Attempt any four:

a) **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.....(1 mark)

or

TPM is the methodology designed to ensure that every machine in a production processalways performs its required risk and its output rate is never disrupted.

The Benefits of TPM.....(Any three..3 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

b)

Wear: Wear is the removal and deformation of material on a surface as a result of mechanical action of the opposite surface.

Wear processes:.....(Any two processes. 2 marks each)

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.

c) Contents of maintenance manual:*.....(Any four. 1 mark each)*

The Maintenance Manual presents information on the system. It is written for personnel who are responsible for the maintenance of the system and who need to understand the operating environment, security, and control requirements. It describes the programs in technical detail to assist the maintenance programmer.

- Major functions performed by the system
- Describe the architecture of the system in non-technical terms (e.g., client/server, web-based, etc.)
- User access mode (e.g., graphical user interface)
- Responsible organization
- System name or title
- System code
- System category:
  - *Major application*: performs clearly defined functions for which there is a readily identifiable security consideration and need
  - *General support system*: provides general ADP or network support for a variety of users and applications
- Operational status:
  - Operational
  - Under development
  - Undergoing a major modification
- General description
- System environment or special conditions

d) Various maintenance tools: .....(1 mark each)

1) Breakdown maintenance: Breakdown maintenance is maintenance that is done after the event
2) Preventive maintenance: Preventative maintenance can be thought of as being like taking your car for a service; we service each machine based either on the time passed or the number of cycles completed; conducting inspections and component replacements as specified by the manufacturers or past experience
3) Predictive maintenance: Predictive maintenance builds on preventive maintenance and uses techniques such as infrared thermal imaging, vibration analysis and oil analysis to try to highlight components that have begun to wear and are likely to fail.
4) Corrective maintenance: The aim of corrective maintenance is to help those responsible for conducting the maintenance and monitoring the machines to do it easily and safely and efficiently.

e) Applications of TPM: .....(1 mark each)

Total Productive Maintenance (TPM) is a business process improvement method, developed from the perspective of maintenance management. TPM concentrates on productivity

improvement, primarily by way of maximizing the availability of equipment. TPM was first applied by the Japanese company Nippondenso, a supplier to the automotive industry.
It finds application in process industry, food production, mass production industry and automotive industry.

Q4 A)

a) Important features of TPM:**....(1 mark for TPM, 3 marks for features)**

TPM is a system of maintaining and improving the integrity of production and qualitysystems 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:

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.

b) Equipments for electric maintenance: .....(1 mark for two items)

Tester, Multimeter, Megger, Tong tester, drill machine, Soldering gun, Earth tester, Insulation tape, Fuse, Screw driver, Plier, Sand paper, Bearing puller, Hammer, Hand gloves, Vax, Torch.

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.

c) Causes of electric fire: Short circuit and overloading are the major causes of fire due to electricity. Various other causes are:....(2 marks for causes)

- Failure of insulation
- Overheating of cables and instruments
- Ignition of flammable gas and vapours by electricity
- Ignition of flammable substances by electrostatic discharge

Preventions of electric fire:.....(2 marks for measures)

1) Avoid overloading your electrical circuits

2) Replace or discard any frayed wiring

3) Replace any old wiring

4) Ensure that every electrical product you use is UL-listed

d) Causes of accident:....(3 marks for causes)

1) Immediate causes: These are direct causes of accident which are due top unsafe acts and unsafe conditions.

- Unsafe acts:
- Ignoring rules
- Operating without knowledge

Operating at unsafe speeds using unsafe equipments

Unsafe conditions:

Unguarded equipments

Overloading of equipments

Slippery floors

Poor housekeeping

2) Contributory Causes: These are indirect causes of accidents. Various contributory causes are:

Mental/Physical condition of worker

Tendency to show off

Extreme temperature

Safety instruction not given

Effects of accidents:.....(1 mark for effects)

Loss of machinery equipments

Loss of life

Personal injury

Loss of working hours

Reduction of working efficiency

Q4 B)

a) Functions and applications of :....(2 marks for each)

I) Multimeter : To measure the AC and DC voltage
` To measure current
To measure resistance
To test continuity of circuit
Testing of diode
Testing of transistor

II) Ammeter: To measure AC current
i. To measure DC current

III) Tube: To give light

b) Wear behaviour due to primary wear process:....(defn: 1 mark. Description: 5 marks)

Wear 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, 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.

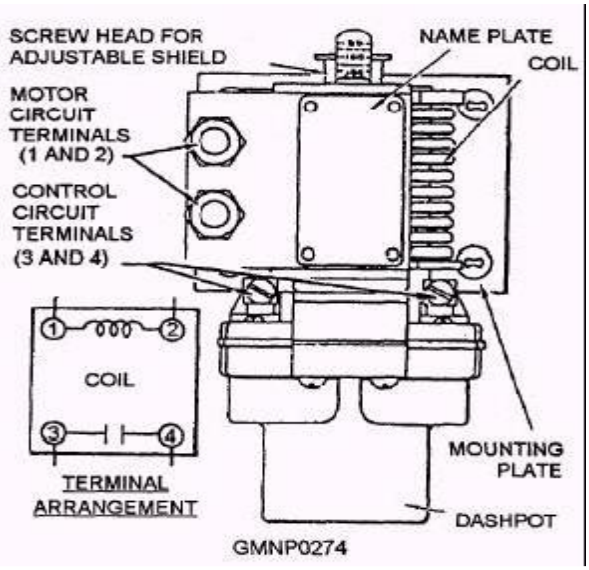
Q5.Attempt any four:

a) Overload relay and voltmeter: (2-sketch & 2- description) (4 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

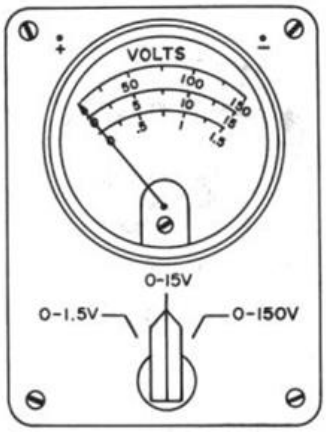
associated 440-volt motor supply circuit and the switch contacts are in a 115-volt start-and-run circuit for the motor.



Voltmeter

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.

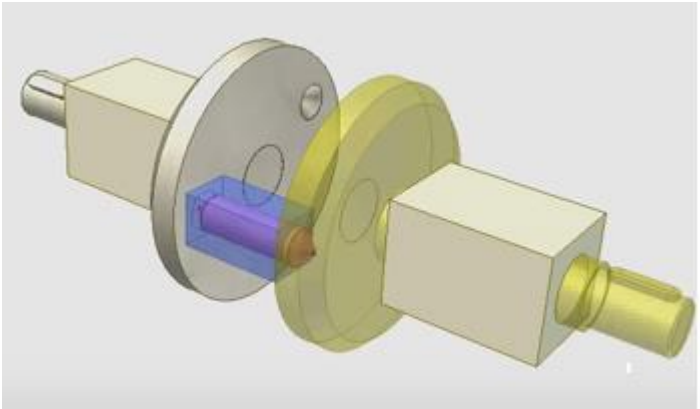
Voltmeters are made in a wide range of styles. Instruments permanently mounted in a panel are used to monitor generators or other fixed apparatus. Portable instruments, usually equipped to also measure current and resistance in the form of a multimeter, are standard test instruments used in electrical 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.



b) Interlocking system for parallel shafts:(2-sketch & 2- description) (4 marks)

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.



b) Personnel Protective equipments:(Any 4 points of type 2 mark & 2- description of type any one) (4 marks)

- Respiratory protection - for example, disposable, cartridge, air line, half or full face.
- Eye protection – for example, spectacles/goggles, shields, visors.
- Hearing protection – for example, ear muffs and plugs.
- Hand protection – for example, gloves and barrier creams.
- Foot protection – for example, shoes/boots.
- Head protection – for example, helmets, caps, hoods, and hats.
- Working from heights - for example, harness and fall arrest devices.
- 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.
- Replace head protection if it is damaged.

Ears

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

- Provide the right hearing protectors for the type of work, and make sure workers know how to fit them
- Choose protectors that reduce noise to an acceptable level, while allowing for safety and communication.

c) Importance of lubricant: (any four points 1 mark each) (1 X4=4)

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.

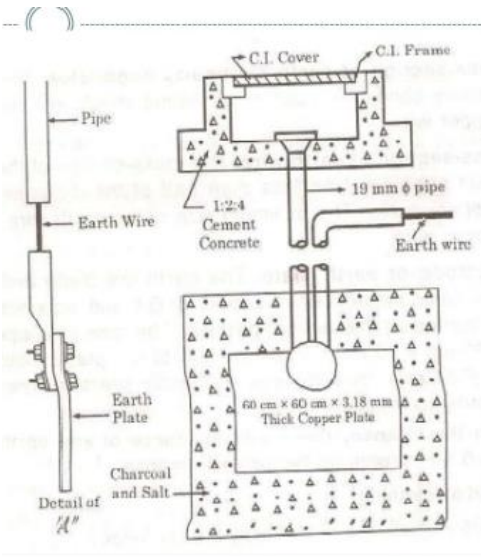
d) Describe any one method of earthing: (2 –sketch & 2- description) (4 marks)

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 15 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.

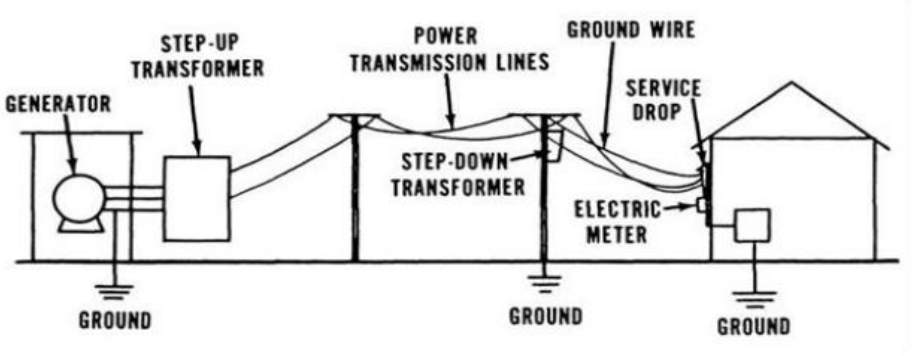


Q6. Attempt any two:

a) Electric power distribution system: (4-sketch & 4- description) (8 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) Preventive maintenance with example:(4 marks for description & 4 for example) (8 marks)

1. The care and servicing by personnel for the purpose of maintaining equipment and facilities in satisfactory operating condition by providing for systematic inspection, detection, and correction of incipient failures either before they occur or before they develop into major defects.
2. Maintenance, including tests, measurements, adjustments, and parts replacement, performed specifically to prevent faults from occurring.

The primary goal of maintenance is to avoid or mitigate the consequences of failure of equipment. This may be by preventing the failure before it actually occurs which Planned Maintenance and Condition Based Maintenance help to achieve. It is designed to preserve and restore equipment reliability by replacing worn components before they actually fail. Preventive maintenance activities include partial or complete overhauls at specified periods, oil changes, lubrication, minor adjustments, and so on. In addition, workers can record equipment deterioration so they know to replace or repair worn parts before they cause system failure. The ideal preventive maintenance program would prevent all equipment failure before it occurs.

The maintenance is scheduled based on a time or usage trigger. A typical example of an asset with a time based preventative maintenance schedule is an air-conditioner which is serviced every year, before summer. A typical example of an asset with a usage based preventative maintenance schedule is a motor-vehicle which might be scheduled for service every 10,000km.

c) Travel control by limit switches::(4 marks for description & 4 for example) (8 marks)

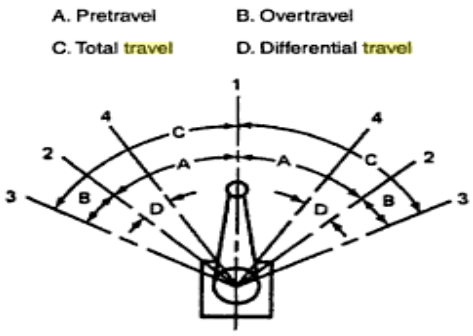
Limit switches are used in a variety of applications and environments because of their ruggedness, ease of installation, and reliability of operation. They can determine the presence or absence, passing,

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".

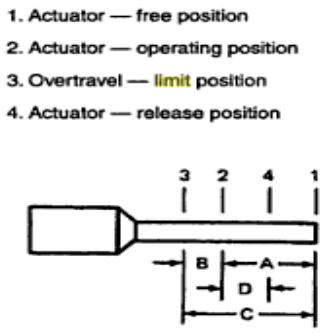
A second important factor is the type of mechanical action available to operate the switch. Here the *operator* is the major decision. Length of travel, speed, force available, accuracy, and type of mounting possible are some of the considerations.

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



LEVER-TYPE SPRING RETURN



PUSH-TYPE SPRING RETURN