(1) Educate about Safety Standards practiced in the machine shop
- Importance of housekeeping and good shop floor practices (3S)

(1) understand the principles of first-Aid.
- preventive measures to be taken during fire and electrical emergency.
- Types of fire extinguishers (Class A, B, C, D)

(3) Knowledge about Safety and Environment Regulations.

* Safety Standards practiced in the machine shop:-

Safety standards in a machine shop are critical to prevent accidents and ensure the well-being of workers.

The key safety practices are:-

(1) personal protective equipment (PPE):-

Always wear appropriate PPE such as:-

i) Safety glasses or goggles to protect against flying debris.

ii) Hearing protection (earplugs or earmuffs) when using noisy equipment.

iii) Steel-toed boots to shield feet from heavy objects.

iv) Gloves suitable for handling materials (avoid gloves near rotating machinery)

v) Respirators or masks when working with hazardous dust or fumes.

(2) Machine operation safety:

- Training :- only trained and authorized personnel should operate machinery.
- Machine guards :- Always use guards and sheilds on machines to prevent contact with moving parts.
- Emergency stops :- Ensure machines have accessible emergency stop buttons.
- Tool handling :- use the correct tools for each job and keep them in good condition.
- Pre-operation checks :- Inspect machines for damage or defects before use.

(3) work area organisation :-

- Cleanliness :- keep the shop clean and free of debris or spills to avoid slips and falls.
- Tool Storage :- Store tools properly after use to prevent accidents.
- Material handling :- use proper lifting techniques or mechanical aids to move heavy items.

(4) Electrical Safety :-

- Ensure all electrical equipment in grounded and regularly inspected
- Avoid using machines with frayed cords and exposed wiring.
- Disconnect power before servicing equipment.

(5) chemical Safety :-

- Store chemicals in labeled containers and follow material safety data sheets (MSDS) for handling and disposal.
- use ventilation systems to reduce exposure to fumes and dust.

(6) Fire Safety :-
- Keep flammable materials away from heat sources.
- Maintain accessible and functional fire extinguishers.
- Avoid overloading electrical circuits.

(7) Behavioral Safety :-
- No loose clothing or jewellry :- These can get caught in machinery
- focus on work :- Avoid distractions and stay alert while working.
- proper Communication :- use standard hand signals or verbal instructions in noisy environments.
- Report hazards :- Immediately report unsafe conditions or malfunctioning equipment.

(8) First Aid and emergency preparedness :-
- Ensure first Aid kits are readily available and stocked
- Train workers in first aid and emergency response
- Develop and practice evacuation plans regularly

* Importance of housekeeping and good shop floor practices (5S) :-

Housekeeping and good shape floor practices, such as implementing (5S) (Sort, Set in order, Shine, Standardize, Sustain) are critical in a machine shop for the following reasons :-

(1) Ensure Safety :-
- A clean and organized machine shop reduces the risk of accidents, such as trips, falls or injuries caused by misplaced tools and materials.
- proper storage of hazardous materials prevent spills, contamination and

(2) Improves efficiency and productivity:-

• 5S principle:-

i) Sort :- removes unnecessary items to avoid clutter and confusion.

ii) Set in order :- ensures tools and materials are organized for easy access, ~~minisi~~ minimizing time spent searching.

iii) Shine :- keeps the work area clean and operational equipment in top condition.

iv) Standardize :- creates uniform procedures that streamline workflow and reduce down time.

v) Sustain :- encourages continuous adherence to good practices, fostering a culture of efficiency.

• A well-maintained shop allows machinists to focus on tasks without distractions or delays caused by disorganization.

(3) Extends equipment life:-

• preventive maintenance :- keeping the shop clean and adhering to maintenance schedules. prevents equipments wear and tear, extending its lifespan.

• Elimination of contaminants :- Dirt, grease and debris can damage machines and tools over ~~the~~ time if not addressed.

(4) Better quality :-

• clean machines :- Regular cleaning and maintenance of machines prevent contamination, wear and breakdowns, leading to consistent product quality.

• Standardization :- Good practices ensure uniformity in operations, reducing errors and defects.

(5) professional appearance :-

• Impression management :- A clean and organized machine shop creates a positive impression on visitors, customers and auditors, showcasing professionalism and Reliability.

* The role of 5S in machine shops :-

5S is a workplace organization method derived from Japanese practices. Each of its five principles contributes directly to improved housekeeping and shop floor practices :-

i) Sort (Seiri) :- Eliminate unnecessary items from the workspace to reduce clutter and improve focus.

ii) Set in order (Seiton) :- Arrange tools, materials and equipment in logical and accessible ways for efficient operations.

iii) Shine (Seiso) :- Regularly clean workspaces, machines and tools to maintain functionality and detect issues early.

iv) Standardize (Seiketsu) :- Develop and enforce standardized practices and procedures to maintain cleanliness and order.

v) Sustain (Shitsuke) :- Foster discipline and encourage continuous improvement to make 5S a part of culture

* understand the principles of first-aid.

first-aid is the initial care given to a person who has injured or suddenly ill. The principle of first-aid is to provide immediate care and relief to the injured or ill person until medical help arrives.

first-aid in a machine shop environment involves and focuses on responding promptly and effectively to injuries, minimizing harm and preventing further incidents.

The principles of first-aid apply:-

i) Ensure safety:- Before helping an injured person, ensure the area is safe, turn off machinery and remove potential hazards to prevent further accidents.

ii) Assess the situation:- Quickly evaluate the injury's severity and identify the type of injury (e.g:- cuts, burns, fractures). Prioritize life threatening issues like severe bleeding or difficulty breathing.

iii) Call for help:- Alert coworkers and if necessary, call emergency services. Prompt professional medical care is crucial for severe injuries.

iv) Provide immediate care:- Heat burns by running cool water over the area (avoid ice or ointments)

v) Prevent infection:- Cleans wounds gently with water if possible and cover them with sterile bandages. Avoid introducing foreign substances to the wound.

* preventive emergency :-

fire and electrical emergencies in machine shops can be hazardous, but implementing proper preventive measures can significantly reduce risks. The important actions to be taken are

fire emergency :-

i) workplace organization :-
- keep flammable materials away from ignition sources.
- ensure the shop is clean and combustible dust is removed

ii) fire detection and suppression :-
- Install fire alarms, smoke detectors and fire suppression systems like sprinklers or extinguishers.

iii) employee training :-
- Train staff on fire prevention, extinguishers use and evacuation procedures.

iv) preventive practices :-
- Inspect machinery for overheating, industrial noise or sparking.

v) signage and pathways :-
- clearly mark emergency exits and keep them unblocked.
- display fire hazard warning near flammable material storage areas.

vi) First aid preparedness :-
- keep first-aid kits readily available in the workshop.

Electrical Emergency :-

i) Electrical equipment maintenance :-
- perform regular maintenance and testing of electrical panels, wiring and machinery.

ii) Grounding and insulation :-
- ensure all equipment is properly grounded.

iii) Surge protection :-
- Surge protectors are installed to handle voltage fluctuations.

iv) Emergency Shutdown :-
- label and make emergency power cutoff switches easily accessible.

v) Environment management :-
- keep electrical component dry and away from water or other conductive liquids.

vi) personal protective equipment (PPE) :-
- wear PPE like insulated gloves, safety glasses and footwear.

Types of fire extinguisher (class A, B, C, D) :-

In a machine shop, the types of fire extinguishers used are determined by the potential fire hazards present. each extinguisher is designed to combat specific types of fire ~~extinguisher~~, categorized into classes A, B, C and D. The extinguishes for each class of fire in machine shops are :.

① class A (ordinary combustibles) :-
fire caused by paper, wood, cloth, rubber and plastic materials

- extinguisher type:- water, foam, or multipurpose ABC dry chemical.

i) water extinguishers:- cools and removes heat.

ii) ABC extinguishers:- versatile for multiple classes.

iii) foam extinguishers:-

② class B (flammable liquids and gases):-
fire caused by flammable liquids like oil, gasoline, paints and solvents.

- extinguisher type:- CO_2, foam and dry chemical.

i) CO_2 extinguisher:- displaces oxygen and cools flammable liquid fires without residue.

ii) foam extinguisher:- prevents vapour release and cools surface

iii) dry chemical extinguisher:- interrupts the chemical reaction of the fire.

③ class C (electrical fires):-
fire involving the electrical equipment, wiring or machinery.

- extinguisher type:- CO_2, or dry chemical

i) CO_2 extinguisher:- Non-conductive; suitable for energized equipment.

ii) ABC extinguisher:- effective on electrical fires while versatile for other classes.

④ class D (combustible metals):-
fires caused by reactive metal such as magnesium, sodium, potassium or aluminium shaving.

- extinguisher type:- class D dry powder extinguishers
  - → specially designed to smother metal fires by forming a crust and absorbing heat.
  - → examples:- sodium chloride or graphite based agents.

* Safety and environment regulations :-

Safety and environmental regulations in a machine shop aim to protect workers from hazards, ensure compliance with government standards and minimize environmental impact.

workplace safety regulations :-

i) Hazard identification and control :-
- conduct a hazard assessment :- Identify risks such as sharp tools, moving machinery, toxic substances or fire hazards.

ii) Safety equipment and PPE :-
- Mandatory personal protective equipment (PPE) :-
  (a) Eye protection (b) Ear protection
  (c) Gloves (d) protective foot wear.

iii) Fire safety :-
- Maintain fire extinguishers for appropriate fire classes (A, B, C & D).
- Train staff in fire extinguisher use and evacuation plans.

iv) Training and emergency procedures :-
- Machine operation training specific to equipment in the shop
- Regular drills for fire, spills or accidents.

v) Ergonomics :-
- Minimize repetitive strain injuries by designing workstations to be ergonomic and adjusting tasks where necessary.

Environmental Regulations :-

i) Hazardous waste disposal :-

- properly dispose of waste like metal shavings coolant or oils.
- follow local hazardous waste storage and disposal rules (e.g- labeling, containment).

ii) Recycling :-

- Scrap materials like metal shavings and discarded parts should be sorted for recycling when possible.

iii) Noise control :-

- High levels of noise from machinery can cause hearing loss, so noise reduction measures, such as sound proofing or noise barriers are recommended to keep noise levels with acceptable limits.

iv) Air quality control :-

- Air bone Contaminants, such as metal dust and mist, should be controlled through ventilation and filtration systems to prevent air-pollution.

Week - 2

(1) lubrication :- • Need of lubrication • selection of lubricant as per ISO standard.

(2) Theory of metal removal :- • Traditional & Non-traditional material removal process • chip forming & Non-chip forming.

(3) Types of cutting tools :- • single point tools • Multi-point tools • specifications of single-point cutting tools. • parting, knurling tool, v-tool.

* **lubrication** :- lubrication is the application of a substance (lubricant) bet^n two moving surfaces to reduce friction, minimize wear and tear and enhance the efficiency and lifespan of the machine components. It ensures smooth operation by creating a thin film that prevents direct-contact bet^n surfaces.

* **Need of lubrication** :-

i) Reduction of friction :- It minimizes resistance bet^n moving parts.

ii) wear protection :- It prevents wear and tear of components such as gears, bearings and slides.

iii) Cooling :- It removes heat generated from friction, protecting components from thermal damage.

iv) Corrosion protection :- It forms a barrier against moisture and contaminants that can cause corrosion.

v) cleanliness :- It washes away debris and microscopic particles from contact areas.

vi) Energy efficiency :- It reduces energy losses due to friction, increasing overall efficiency.

vii) Extended equipment life :- It ensures longevity and reliability of machine tools.

Selection of lubricants as per ISO Standard :-

ISO standards offer guidelines to ensure that lubricants match specific operating conditions and machines requirements.

factors to be considered for selecting lubricants :-

i) Viscocity (ISO VG Standards) :-

Viscocity is the most critical property of a lubricant. ISO 3448 categorizes lubricants into ISO viscosity Grades (ISO VG), such as- ISO VG 32, 46, 68 etc.

selection depends on:

- Speed and load of moving parts.
- Ambient and operating temperatures.

ii) Application-Specific guidelines :-

ISO standards provide tailored lubricant recommendations for different machine components :-

- Bearing and gears :- follow ISO 12925 for industrial gear lubricants.
- Hydraulic systems :- ISO 11158 defines categories for hydraulic oils.
- Slideways and Guides :- use lubricants as per ISO 6748-13 for smooth movement.

iii) Environmental Considerations :-

ISO 14001 promotes environmentally friendly lubrication, emphasing biodegradable or low-toxicity lubricants.

iv) Lubricants additives :-

ISO standards specify the need for additives like:
- Anti-wear (AW) and extreme pressure (EP) additives for high load applications
- Anti-oxidation additives to enhance lubricant life.

v) Compatibility with materials :-

Ensure the lubricant complies with ISO standards on material compatibility (e.g- of elastomers, seals or coatings).

vi) Certification and Testing :-

- ISO 3016 : Determines pour point of lubricant for cold weather.
- ISO 4259 : Assures compatibility and oil bending consistency.
- ISO 6743 : categories lubricant types of machinery.

Theory of Metal Removal :-

The theory of metal removal involves understanding the mechanics, thermodynamics and dynamics of cutting or shearing materials. The process generally involves removing unwanted material from a workpiece to form the desired shape and dimensions using tools like lathe, milling, drilling or grinding machines.

- Fundamentalmental concepts of metal-removal :-

① Mechanics of cutting :-

- plastic deformation :- Metal removal occures primarily due to plastic deformation. The material is compressed and

sheared off as chips when the cutting tool applies sufficient force.

- Shear zone :- The area where material is deformed and removed as a chip. It consists of primary and secondary shear zones.

- Cutting forces :- Generated at the tool-workpiece interface and include forces in tangential, radial and axial - directions.

iii) Material properties :-

- workpiece materials influence machinability, affecting cutting speed, tool life and surface finish.
- properties like hardness, toughness and ductility determine how easily the material can be cut.

iii) Tool design :-

- The cutting tool must have the proper geog geometry, includ including rake angle, clearance angle and cutting edge angle for efficient chip removal.
- Tool material (e.g- high-speed steel, carbide or ceramics) affects wear resistance and cutting performance.

iv) Heat generation :-

- Metal cutting generates significant heat due to friction and plastic deformation.
- Heat management often by coolant or lubrications is essential to maintain tool life and workpiece quality.

(v) chip formation :-

- Types of chips include continuous, segmented or discontinuous depending on material properties and cutting conditions.
- proper chip control prevents tool damage and ensures operator safety.

(vi) Surface finish and integrity :-

- The quality of the machined surface depends on cutting parameters like speed, feed and depth of cut.
- Minimizing defects such as burns, burrs or thermal damage is essential.

→ Key parameters in metal removal :-

(i) cutting speed (v) :- The velocity at which the cutting tool moves relative to the workpiece, Higher speed improve productivity but can reduce tool life.

(ii) Feed rate (f) :- The distance the tool advances per revolution of the workpiece. It affects surface roughness and material removal rate.

(iii) Depth of cut (d) :- The thickness of material removed in one pass, larger depths increase cutting forces.

Traditional and Non-traditional material removal process :-

Material removal processes can be classified into traditional and non-traditional methods depending on the type of energy used for machining and mechanism of material removal.

1. Traditional material removal processes :- These processes use physical contact bet^n the cutting tool and the workpiece. Material is removed by plastic deformation or shear.

* Characteristics :-
- utilize mechanical energy for material removal.
- cutting tools or abrasives are used to apply forces
- Tool wear and heat generation are significant concerns.

• Suitable for metals, polymers and other machinable materials.

* Examples of Traditional processes :-

(i) Turning (lathe) :-
Removes material from a rotating workpiece using a single-point cutting tool.
Applications :- shafts, cylindrical parts.

(ii) Milling :- Rotating multi-point tools remove materials
Applications :- flat surfaces, slots and contours.

(iii) Drilling :- cylindrical holes are created using a rotating drill bit.
Applications :- Holes for fasteners or piping.

(iv) Grinding :- Abrasive wheels remove material for fine-finishes and precision.
Applications :- Tool sharpening, smooth surfaces.

(v) shaping and planing :- the cutting tool moves linearly to remove material from flat surfaces.
Applications :- flat or angular surfaces.

(vi) Sawing :- cutting material into pieces with a toothed blade.
Applications :- cutting raw-materials to size

2. Non-traditional Material removal process :-
Non-traditional processes employ various forms of energy (thermal, chemical, electrical or mechanical) rather than mechanical contact for material removal.

* Characteristics :-
• effective for hard-to-machine or complex materials.
• No direct, NO direct contact bet^n tool and workpiece in most case.
• capable of producing intricate shapes and features.
• Minimal tool wear compared to traditional methods.

* examples of Non-traditional processes :-

(i) Electrical discharge Machining (EDM) :
uses electrical sparks to erode materials.

Applications :- Intricate molds, dies and aerospace parts.

(ii) laser beam Machining (LBM) :- High energy laser vaporizes or melts materials.

Applications :- precision cutting of metals and composites.

(iii) water jet machining (WJM) :- High pressure water (sometimes mixed with abrasives) cuts material.

Applications : Heat-sensitive materials like composites and plastics.

(iv) Electrochemical Machining (ECM) :- Material is dissolved via electrochemical reactions.

Applications :- Turbine blades, Medical implants.

(v) ultrasonic Machining (USM) :- Abrasive particles driven by ultrasonic waves erode materials.

Applications :- Brittle materials like ceramic and glass.

(vi) plasma arc Machining (PAM) :- A high velocity plasma jet melts materials for removal.

Applications :- Thick or conductive metals, especially in steel cutting.

(vi) Chemical Machining (CHM) :- Materials is etched away using chemical solutions.

Applications :- Thin or intricate parts like foils or films.

* Comparison:-

	Aspect	Traditional	Non-Traditional
(i)	Energy Source	Mechanical	Thermal, electrical, chemical or mechanical
(ii)	Too-work interaction	Physical contact	indirect (energy-based methods)
(iii)	Tool wear	Significant	Minimal
(iv)	precision	Moderate	High
(v)	Heat generation	High	Controlled or localized
(vi)	Surface finish	Good to rough	Excellent in most cases
(vii)	Material Applicability	limited to ductile / machinable materials	effective for hard to machine or brittle materials
(viii)	Cost	Generally low	High (specialised equipment)
(ix)	Complex shapes	Difficult	Easy to achieve.

- Traditional processes are suitable for bulk-materials removal, high production environments or standards machinable metals (steel, aluminium)
- Non-Traditional processes are preferred for aerospace, medical and electronics industries, where precision, complex geometries or hard materials are required.

Chip forming and Non-chip forming processes :-

In machining and manufacturing, material removal processes are categorized as chip forming or Non-chip forming based on how the material is removed.

1) Chip-forming processes :- Chip forming processes involve the removal of material in the form of chips. These processes rely on mechanical cutting tools that shear the material from the workpiece

* chip forming processes are :-
  (i) Turning
  (ii) Milling
  (iii) Drilling
  (iv) Grinding
  (v) Shaping and planing

* Key features :-
  - Involves plastic deformation of the material to generate chips.
  - Suitable for both rough cutting and fine finishing.
  - produce heat and wear on tool due to friction

(2) Non-chip forming processes :- Non-chip forming processes remove or shape material without the creation of chips. These typically use chemical, electrical or thermal energy instead of mechanical cutting.

* Non-Chiping forming processes are :-
  (i) Electrochemical Machining (ECM)
  (ii) Electrical discharge machining (EDM)
  (iii) laser beam Machining (LBM)
  (iv) water Jet Machining (WJM)
  (v) Chemical milling
  (vi) Not forming processes (i.e. forging)

* Key features :-

- No direct tool engagement required to shear the material
- More suited for hard or intricate workpieces.
- Can produce smooth or intricate finishes with minimal material wastage.

* Comparison :-

Aspect	chip-forming	Non-chip forming.
(i) Mechanism	Meachanical shearing of material	Thermal chemical or electrical energy.
(ii) Chips generation	produce chips	No chips generated
(iii) Material Applicability	limited to machinable material.	Hard, brittle or heat sensitive materials.
(iv) Tool contact	Direct contact	Minimal or No-contact
(v) precision	Moderate to high	very high
(vi) Heat generation	significant due to friction	dependent on method but controlled.