THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATION COUNCIL OF TANZANIA

DIPLOMA IN TECHNICAL EDUCATION EXAMINATION

789 METAL WORKING AND MECHANICAL PRACTICE

Time: 3 Hour. **ANSWERS** **Year: 2007**

Instructions

1. This paper consists of **eight (8)** questions.
2. Answer any **five (5)** questions.
3. Each question carries **twenty (20)** marks.
4. Non-programmable calculators may be used.
5. Communication devices, programmable calculators and any unauthorized materials are **not** allowed in the examination room.
6. Write your **Examination Number** on every page of your answer booklet(s).

1. (a) Marking out in mechanical workshop practice refers to the process of transferring measurements and dimensions from technical drawings onto a metal workpiece. It is a preparatory step used to guide cutting, drilling, and shaping processes accurately.

(b) (i) The condition of the marking out surface affects accuracy because dirt or unevenness can distort layout lines. The precision and sharpness of tools used also influence line clarity. The operator's skill and ability to maintain tool alignment during scribing play a key role in achieving accurate results.
(ii) A scriber is used to draw fine lines on metal surfaces. A steel rule is used for measuring and drawing straight lines. A try square is used to draw and check 90-degree angles on the workpiece.

(c) Errors during marking out can occur from incorrect measurement readings, leading to misplaced lines. Using worn-out tools may result in vague or double lines. Misalignment of tools causes angles and lengths to deviate from the required specification. Applying inconsistent pressure while scribing can also result in invisible or excessively deep marks.

(d) Accuracy in layout operations can be improved by using well-maintained and sharp tools. Working on a clean and flat marking surface eliminates inconsistencies. Double-checking dimensions before scribing reduces mistakes. Proper clamping of the workpiece prevents movement during marking.

2. (a) A tool post is the component on a lathe machine where the cutting tool is mounted. It allows the tool to be held firmly and adjusted to the desired angle and height for efficient machining.

(b) (i) The single tool post holds one tool at a time and is commonly used for basic turning. The four-way tool post allows mounting of four tools that can be rotated into position, saving setup time during multi-operation machining.
(ii) Setting the tool height correctly ensures that the cutting edge is aligned with the workpiece center. This avoids rubbing, reduces tool wear, and improves surface finish.

(c) Incorrect tool alignment can cause poor surface finish due to improper cutting angles. It increases tool wear because of uneven pressure distribution. It may also lead to inaccurate dimensions and tapering on the turned surface.

(d) Common turning operations include facing, where the tool cuts the end of the workpiece flat. Straight turning reduces the diameter of a cylindrical part. Thread cutting produces helical grooves, and grooving creates recesses on the workpiece surface.

3. (a) Tempering is a heat treatment process performed after hardening to reduce the brittleness of metal while retaining sufficient hardness. It improves toughness and allows tools to absorb impact without cracking.

(b) (i) Tempering relieves internal stresses caused by hardening. It decreases brittleness and increases toughness. It improves resistance to impact and fatigue.
(ii) Tools such as cold chisels and punches must be tempered to withstand repeated striking without breaking.

(c) To temper a cold chisel, first harden it by heating to red-hot and quenching in water. Then clean the tool and slowly reheat it until a light straw or blue color appears on the cutting edge, indicating the desired temper. Immediately quench it again to lock in the temper.

(d) Overheating during tempering may cause the metal to become too soft, reducing its cutting ability. It can also cause grain growth, which weakens the material. Excessive temperature may result in uneven tempering, leading to inconsistent tool performance.

4. (a) A coolant is a fluid used in metal cutting to absorb heat generated during machining. It prevents overheating of both the workpiece and the cutting tool, thus prolonging tool life and improving surface finish.

(b) (i) Soluble oils are used in general machining for cooling and lubrication. Synthetic coolants are suitable for high-speed operations like grinding. Straight oils are used in low-speed operations such as tapping or threading.
(ii) Coolants reduce friction between the tool and the material, decreasing tool wear. They also carry away chips and debris, ensuring smooth operation and better visibility.

(c) Without proper cooling, tools may overheat and fail prematurely. The workpiece may warp or expand, affecting dimensional accuracy. Excessive heat can also cause poor surface finish and burn marks.

(d) Wear gloves and eye protection to prevent skin and eye irritation. Ensure proper ventilation to avoid inhaling fumes or mist from cutting fluids.

5. (a) A machine vice is a device mounted on machine tables to hold workpieces during operations such as drilling or milling. It ensures the workpiece remains stationary for accurate and safe machining.

(b) (i) A machine vice is bolted to a machine bed and designed to withstand machining forces, while a bench vice is mounted on a workbench and used for hand operations.
(ii) A machine vice is used in drilling to hold the workpiece, in milling for precise cuts, and during grinding operations to secure the component.

(c) When clamping, ensure the workpiece is clean to prevent slipping. Use soft jaws or protectors to avoid surface damage. Check alignment before tightening to maintain correct orientation.

(d) Improper clamping can lead to vibration, which affects surface finish and tool life. It may cause the workpiece to shift during operation, leading to dimensional errors or accidents.

6. (a) Shearing is the process of cutting sheet metal using blades without forming chips. It is important in shaping large sheets quickly and is used for preparing blanks in fabrication.

(b) (i) Shearing tools include hand shears for light-duty work, lever shears for medium-duty tasks, and guillotine shears for heavy-duty sheet cutting.
(ii) A guillotine shear works by lowering a straight blade vertically across the sheet against a fixed lower blade. The shearing action produces a clean, straight cut across the metal.

(c) Keep hands clear of the blade area to avoid injury. Always use guards and wear gloves and goggles. Ensure the sheet is properly aligned before cutting. Do not cut hardened materials with standard shears.

(d) Shearing may cause slight distortion or burrs at the cut edge. It is also limited to straight-line cuts, unlike sawing which can be used for more complex shapes.

7. (a) A slot drill is a two-flute milling cutter used to cut slots and holes in metal. It is capable of plunging directly into the workpiece and is commonly used in vertical milling machines.

(b) (i) A slot drill has two cutting edges and is primarily used for slotting, while an end mill has multiple flutes and is used for contouring and profile cutting.
(ii) Slot drills are used to cut keyways and slots and to produce pockets in flat surfaces.

(c) Tool deflection during slot milling can result from excessive feed rate, which overloads the cutter. Using a long or slender cutter increases flexibility. Incorrect tool material may not withstand cutting forces, leading to bending.

(d) Tool deflection can be prevented by using a rigid setup and minimizing tool overhang. Selecting the correct feed and speed for the operation is also important. Using carbide tools improves stiffness. Applying proper cutting fluid reduces heat and stress.

8. (a) Surface finish refers to the texture and smoothness of a machined surface. It affects how components fit, move, and seal in mechanical assemblies. A good surface finish reduces friction and improves wear resistance.

(b) (i) Tool sharpness directly impacts the smoothness of the finish. Feed rate determines how coarse or fine the tool marks appear. Machine vibration can cause chatter and irregular patterns.
(ii) Poor surface finish increases wear due to friction. It can also lead to improper sealing or fitting, especially in precision assemblies.

(c) A higher feed rate usually results in a rougher surface finish, while a lower feed rate produces a smoother finish. Controlling feed rate is critical in achieving desired surface quality.

(d) Surface finish can be improved by using sharp, well-ground tools. Reducing the feed rate and increasing spindle speed helps create smoother surfaces. Proper alignment and stable setup reduce chatter and improve consistency.