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: 2008**

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) Workpiece holding refers to the act of securing a metal component firmly in position during machining, drilling, or fitting operations. This ensures stability, safety, and accuracy while the operation is being performed.

   (b) (i) Holding the workpiece firmly prevents movement, which could lead to incorrect cuts or injuries. It ensures accuracy of dimensions during machining. It also reduces vibration that can damage both the tool and the workpiece.
   (ii) A bench vice is used to clamp workpieces for filing or sawing. A machine vice holds parts on a drill or milling machine. A chuck secures round or irregular pieces in lathe or drilling machines.

   (c) Poor clamping can lead to workpiece shifting during cutting, which causes inaccuracies. It may result in tool breakage due to jamming or excess vibration. It increases the risk of injury as the workpiece may eject unexpectedly. It also causes uneven surface finish and rejects in production.

   (d) Magnetic chucks are fast and easy to use, especially for holding flat workpieces. They provide uniform clamping without damaging surfaces. However, they may not hold non-ferrous metals like aluminum. They also lose effectiveness if the surface is not clean or flat.

2. (a) A thread pitch gauge is a measuring tool used to determine the pitch or spacing of threads on screws, bolts, or taps. It consists of multiple blades with teeth that match standard thread pitches.

   (b) (i) Metric thread pitch gauges measure threads in millimeters, while imperial thread pitch gauges measure threads in threads per inch (TPI).
   (ii) Limitations include difficulty in using on dirty or worn threads, and they may not cover all non-standard thread sizes.

   (c) To check the pitch of a bolt, select a blade from the pitch gauge set and match its teeth with the thread on the bolt. If the teeth align perfectly and no gap is visible, then that blade's pitch corresponds to the bolt.

   (d) Always clean the thread and gauge before measurement. Ensure full contact between gauge and thread. Avoid using worn-out blades. Store the pitch gauge in a dry place to prevent rusting.

3. (a) Orthographic projection is a method of representing three-dimensional objects in two dimensions using multiple views. Each view shows the object as seen from a different angle such as front, top, or side.

(b) (i) The front view shows height and width. The top view shows width and depth. The side view shows height and depth.
(ii) Hidden lines represent edges or surfaces not visible from the current view. Centre lines indicate axes of symmetry or paths for drilling.

(c) In first angle projection, the object is placed between the viewer and the plane of projection. In third angle projection, the plane is placed between the viewer and the object. Their view placement on paper differs accordingly.

(d) Accurate orthographic drawings help machinists understand dimensions and shape clearly. They guide marking out and machining. They ensure standard communication between engineers and technicians. They also allow proper checking and inspection.

4. (a) A drilling jig is a tool used to guide the drill bit into a specific position repeatedly during drilling operations. It ensures accuracy and consistency across multiple parts.

(b) (i) Jigs reduce time spent measuring and marking each part. They improve drilling accuracy and alignment. They allow unskilled workers to perform precision drilling.
(ii) Jigs can be expensive to manufacture. They are only useful for specific components and require storage space.

(c) A drill jig uses bushings or sleeves to guide the drill exactly where the hole is required. Since the workpiece is held within the jig, each repetition maintains the same dimensions and location.

(d) Jigs are made from steel for durability, aluminum for lightweight applications, cast iron for stability, and plastic for light-duty or prototype parts.

5. (a) Heat conductivity refers to a metal's ability to transfer heat. It is an important property in cutting operations, as it affects heat dissipation from the tool and workpiece.

(b) (i) Copper is an excellent heat conductor used in electrical components. Aluminum is used in heat sinks. Brass is used in valves and fittings due to moderate conductivity.
(ii) Poor heat conductivity can cause heat buildup at the cutting zone, leading to tool failure. It may also cause thermal distortion in the workpiece, reducing accuracy.

(c) Copper is preferred because it efficiently transfers heat away from hot zones. This prevents damage to components and helps maintain thermal stability in machinery.

(d) Low heat conductivity materials like stainless steel are used in oven linings, insulating handles, and fireproof panels where heat retention is desired.

6. (a) Bench drilling is the process of drilling holes using a small drill press mounted on a workbench. It is commonly used for light and medium-duty work in workshops or training institutions.

(b) (i) To drill a 10 mm hole, mark the center with a centre punch. Secure the bar in the machine vice. Fit the 10 mm drill bit into the chuck. Apply cutting fluid and align the bit with the mark. Drill slowly with steady feed until the hole is complete.
(ii) Problems include drill bit wandering if not centered properly and overheating due to lack of cutting fluid or improper speed.

(c) Wear safety goggles and avoid loose clothing. Clamp the workpiece securely. Use the correct drill bit and cutting fluid. Keep hands away from rotating parts.

(d) Correct drill speed prevents tool overheating and extends tool life. Correct feed rate improves chip removal and ensures clean holes without damage to the bit or material.

7. (a) A centre lathe is a versatile machine used to perform operations like turning, facing, and thread cutting on cylindrical workpieces. It is widely used in manufacturing and repair workshops.

(b) (i) A three-jaw chuck holds round workpieces. A faceplate allows mounting of irregular shapes. A fixed steady supports long workpieces.
(ii) The tailstock holds drills or supports long workpieces from the opposite end of the chuck to prevent deflection and vibration.

(c) In compound slide taper turning, the compound rest is set to the desired taper angle. The tool is advanced manually along this angle while the workpiece rotates, producing a taper along its length.

(d) Do not wear gloves near rotating parts. Ensure the workpiece is tightly secured. Always remove the chuck key after setting up. Never leave the machine unattended while it is running.

8. (a) Micrometre calibration is the process of checking and adjusting a micrometre to ensure it provides accurate measurements. It is necessary to maintain measurement reliability in precision work.

(b) (i) Errors can come from a worn spindle or anvil. Dirt or oil on the measuring faces can cause incorrect readings. Thermal expansion from hand heat also affects accuracy.
(ii) To check accuracy, close the micrometre and ensure it reads zero. Use standard gauge blocks to compare the reading with a known dimension. Adjust if necessary.

(c) Always clean the micrometre before use. Do not overtighten the spindle. Use the ratchet mechanism for consistent pressure. Store in a dry, protected case to prevent damage.

(d) An uncalibrated micrometre may lead to incorrect measurements, causing parts to be rejected. It can also result in poor fits or unsafe assemblies, especially in high-precision components.