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: 2016**

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) Define "cold working" and mention two examples.

Cold working is a metal forming process performed at or near room temperature where the metal is plastically deformed without being heated. This process increases the strength and hardness of the material due to strain hardening.

Examples of cold working include cold rolling and wire drawing.

(b) (i) State four advantages of cold working processes.

Cold working improves the surface finish of the metal, making it smooth and suitable for finished products without further processing.

It enhances the strength and hardness of the metal through strain hardening.

Cold working reduces the risk of oxidation or scaling that normally occurs in hot processes.

It produces more accurate dimensions and tighter tolerances due to minimal thermal expansion.

(ii) Explain the effect of cold working on metal grain structure.

Cold working distorts the original grain structure of the metal, causing grains to elongate in the direction of deformation. This results in increased dislocation density, making the metal stronger and harder, but also less ductile.

(c) Describe how cold rolling is performed.

Cold rolling is performed by passing the metal through rollers at room temperature. The rollers compress and elongate the metal, reducing its thickness and increasing its length. This process enhances the mechanical properties and surface finish of the material.

(d) State four safety precautions observed during cold working operations.

Operators must wear safety gloves and goggles to protect hands and eyes from sharp edges and flying debris.

Workpieces should be securely clamped or guided to avoid slipping during deformation.

Proper lubrication must be used to reduce friction and prevent accidents.

Machine guards and emergency stop buttons should be functional and easily accessible.

2. (a) What is a "micrometer screw gauge"?

A micrometer screw gauge is a precision measuring instrument used to measure small dimensions such as the thickness or diameter of a component with high accuracy, usually to the nearest hundredth of a millimeter.

(b) (i) Identify three main parts of a micrometer and explain their functions.

The anvil is the stationary part against which the object is placed.

The spindle is the movable part that approaches or retracts from the anvil to hold the object.

The thimble is the rotating part that moves the spindle and is used to take precise readings.

(ii) Explain the procedure of taking a measurement using a micrometer.

Place the object between the anvil and spindle. Turn the thimble slowly until the spindle contacts the object gently. Lock the spindle using the ratchet to avoid overtightening. Take the reading from the sleeve and thimble scales.

(c) Describe how to read a micrometer with a main scale reading of 7.5 mm and thimble reading of 0.28 mm.

The total measurement is obtained by adding the sleeve (main scale) reading and the thimble reading. So, 7.5 mm + 0.28 mm = 7.78 mm.

(d) State four common errors made when using a micrometer and how to avoid them.

Applying excessive pressure can deform the object or give incorrect readings, so the ratchet should always be used.

Dirty or oily surfaces can result in slippage, so the instrument and object must be clean.

Reading the wrong scale due to unfamiliarity, which can be avoided by proper training.

Failure to zero the micrometer before use leads to inaccurate readings; always check and calibrate first.

3. (a) Define "spot welding" and explain its principle.

Spot welding is a type of resistance welding where heat is generated at the contact point of two metal surfaces by passing electric current through them. The localized heat melts the metal, forming a weld as it cools.

(b) (i) State three components of a spot welding machine.

The electrodes conduct current and apply pressure on the metal surfaces.

The transformer reduces high voltage to low voltage, high current suitable for welding.

The timer controls the duration of current flow to ensure proper welding time.

(ii) List three metals suitable for spot welding.

Low carbon steel is commonly used due to its good conductivity.

Stainless steel is suitable with proper settings to handle its resistance.

Aluminum can be spot welded but requires special equipment due to its high thermal conductivity.

(c) Describe the steps for making a spot weld.

Clean the metal surfaces to remove rust and oil. Position the sheets between the electrodes. Apply pressure using the electrodes. Pass electric current for a controlled time to generate heat. Maintain pressure during cooling for a strong weld.

(d) State four limitations of spot welding in production.

It is limited to lap joints and cannot weld thick materials.

Appearance may not be suitable for visible areas.

Requires precise control of time and pressure.

High equipment cost and energy usage.

4. (a) What is meant by "grit size" in abrasive wheels?

Grit size refers to the size of the abrasive particles in a grinding wheel. It determines the surface finish and material removal rate during grinding.

(b) (i) Differentiate between coarse grit and fine grit.

Coarse grit has larger abrasive particles, removes material faster but leaves rough surfaces.

Fine grit has smaller particles, removes material slowly but produces a smoother surface finish.

(ii) State the significance of grit size in grinding operations.

Grit size affects both the finish and efficiency of the grinding operation. Coarser grits are used for rapid stock removal, while finer grits are used for finishing and precision grinding.

(c) Explain how to select an abrasive wheel for grinding mild steel.

Choose a medium grit size (such as 60 to 80) suitable for mild steel. Use an aluminum oxide wheel since it is appropriate for ferrous metals. Ensure the wheel is balanced and suitable for the grinder's speed.

(d) State four safety rules when handling and storing abrasive wheels.

Always store wheels in a dry, flat location to prevent warping.

Inspect wheels for cracks before mounting.

Use proper wheel guards on machines.

Avoid dropping or striking wheels as they can break or weaken.

5. (a) Define the term "reaming" and state its purpose.

Reaming is a finishing operation that uses a multi-edge tool called a reamer to enlarge or refine a previously drilled hole for improved dimensional accuracy and surface finish.

(b) (i) List two types of reamers used in workshops.

Hand reamers are operated manually using a wrench.

Machine reamers are mounted on machines like lathes or drill presses.

(ii) Explain how reaming differs from drilling.

Drilling removes material to create a hole, often roughly.

Reaming refines the hole by smoothing the internal surface and achieving precise size.

(c) Describe the correct procedure of reaming a hole after drilling.

Drill a hole slightly smaller than the final size. Align the reamer properly and apply lubricant. Rotate the reamer slowly and steadily into the hole without reversing. Remove the reamer with a single smooth motion.

(d) State four precautions to observe when performing reaming operations.

Do not reverse the reamer while inside the hole.

Use the correct size drill bit before reaming.

Apply lubricant to prevent tool wear.

Keep the reamer sharp and clean for accuracy.

6. (a) What is meant by "center drilling"?

Center drilling is a preliminary drilling operation used to create a small, accurately positioned hole at the center of a workpiece. This hole guides the main drill and helps prevent it from wandering during further drilling or turning operations.

(b) (i) Explain why center drilling is done before turning operations.

Center drilling ensures that the workpiece is properly aligned on the lathe centers. It provides a starting point for tailstock support, reduces tool deflection, and helps maintain dimensional accuracy during turning.

(ii) State two types of center drills.

The plain center drill has a straight tip and is used for shallow center holes.

The bell-type center drill has a slightly conical shape and is used where deeper or more supported centers are needed.

(c) Describe how to correctly perform center drilling on a lathe.

Mount the workpiece in the chuck securely. Fix the center drill in the tailstock spindle. Align the tailstock with the workpiece axis. Start the lathe at moderate speed, advance the center drill steadily into the workpiece with cutting fluid. Withdraw once the desired depth is achieved.

(d) State four effects of improper center drilling.

It can cause misalignment of the workpiece, leading to inaccurate turning.

Improper depth may result in poor support from the live center.

Overheating and dulling of the drill may occur due to excessive feed.

Tool breakage or chatter may happen due to poor alignment or speed setting.

7. (a) Define "tolerance" in the context of engineering fits.

Tolerance is the permissible limit of variation in a physical dimension of a manufactured part. It ensures interchangeability, proper function, and fit between mating components.

(b) (i) Give two examples of tolerance applications in metal parts.

Shaft and bearing assemblies where the shaft must fit freely but securely within the bearing.

Bolt and hole combinations where the bolt must pass through the hole without excess play.

(ii) Explain the consequences of ignoring tolerances in production.

Ignoring tolerances leads to poor fitting parts that may be too loose or too tight. This can result in assembly failure, reduced product performance, increased wear, or rejection of components during quality inspection.

(c) Describe the procedure for calculating limits of tolerance for a shaft of 20 mm with ±0.02 mm.

The upper limit is calculated by adding the tolerance to the nominal size: 20 + 0.02 = 20.02 mm.

The lower limit is calculated by subtracting the tolerance: 20 - 0.02 = 19.98 mm.

Therefore, the acceptable range for the shaft diameter is 19.98 mm to 20.02 mm.

(d) State four benefits of proper tolerance control in machining.

It ensures consistent product quality and performance.

Reduces rework and rejection rates during inspection.

Allows for smooth and functional assembly of parts.

Helps in cost control by reducing material waste and production time.

8. (a) What is a "drill press" and what is its function?

A drill press is a fixed machine tool used for drilling precise holes in materials. It consists of a spindle driven by a motor and mounted on a column, allowing controlled vertical movement of the drill bit into the workpiece.

(b) (i) Identify three parts of a drill press and explain their use.

The base supports the entire machine and provides stability.

The table holds the workpiece and can be adjusted vertically.

The spindle rotates the drill bit and delivers cutting action to the material.

(ii) State three advantages of using a drill press over a hand drill.

A drill press offers greater accuracy and consistency in hole placement.

It allows for controlled drilling pressure and depth.

It can handle larger and tougher workpieces more efficiently than a hand drill.

(c) Describe the steps involved in operating a drill press safely.

Secure the workpiece firmly on the table using clamps or a vice.

Select the appropriate drill bit and mount it securely in the chuck.

Adjust the table height and set the desired drilling depth.

Start the machine and lower the spindle slowly using the feed handle.

Apply cutting fluid if necessary, and withdraw the bit after reaching the desired depth.

(d) State four hazards associated with drill press operations and how to prevent them.

Loose clothing or hair can get caught in rotating parts, tie back hair and wear fitted clothing.

Flying chips can cause eye injuries, always wear safety goggles.

Unsecured workpieces can spin or fly, clamp the workpiece properly.

Overheating can damage tools and cause burns, use cutting fluid and allow cool-down.