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: 2001**

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) (i) Workshop safety refers to the set of rules, practices, and precautions put in place to prevent accidents and injuries while working in a mechanical workshop. It ensures that both personnel and equipment are protected from harm or damage during operations.

(ii) Five general safety rules in a mechanical workshop include:

- Always wear appropriate personal protective equipment (PPE), such as goggles, gloves, and safety boots, to protect the body from hazards.
- Keep the work area clean and free from oil spills or scattered tools to avoid slips and injuries.
- Do not operate any machinery without proper training or supervision to prevent misuse or accidents.
- Switch off machines completely and disconnect from power when making adjustments or repairs.
- Report any damaged tools or machines to supervisors immediately for repair or replacement to avoid potential risks.

(b) A centre punch is a hand tool used in marking out to create small indentations in metal surfaces to guide drills and prevent wandering. It ensures that holes are drilled at the correct position. There are two types: the prick punch, which has a sharper angle and is used for light marking, and the centre punch, with a blunter tip, used for guiding drills.

(c) (i) Three precautions when using a hammer in fitting work include:

- Always grip the hammer handle firmly to maintain control during use.
- Use the correct type and size of hammer for the specific job to avoid tool damage or poor results.
- Ensure the hammer head is securely fixed to prevent it from flying off and causing injury.

(ii) Four types of hammers and their uses are:

- Ball peen hammer: Used for peening rivet heads and general metalwork.
- Cross peen hammer: Useful for working in corners and edges where space is limited.
- Straight peen hammer: Used in forging and shaping metal.
- Soft face hammer: Made of rubber or plastic, ideal for assembling delicate parts without

damaging surfaces.

2. (a) The procedures involved in preparing a metal surface for marking out include:

- Cleaning the surface with a cloth or brush to remove oil, rust, or debris.
- Filing the surface to remove irregularities or burrs that may affect accuracy.
- Applying a thin coat of layout fluid or chalk to improve visibility of scribed lines.
- Ensuring the workpiece is properly clamped or secured on the marking out table.

(b) Three common layout tools and their uses are:

- Scriber: Used for drawing fine lines on metal surfaces for marking cut points or holes.
- Steel rule: Measures distances accurately during layout operations.
- Try square: Used to check and mark right angles (90 degrees) on metal workpieces.

(c) The parts of a scribing block include:
(i) Scriber – a hardened steel point used to draw layout lines.
(ii) Column – the vertical rod that supports the scriber arm and allows height adjustment.
(iii) Base – the flat and heavy part that stabilizes the tool on the surface.
(iv) Fine adjustment screw – used to finely move the scriber up or down for precise layout.

(d) In the sketch, the scribing block stands on a surface plate with its base flat and the scriber pointing toward the metal workpiece, positioned horizontally to mark the desired line.

3. (a) Four methods of mechanical joining include:

- Riveting: Joining materials using metal pins (rivets) that are deformed to hold parts together.
- Bolting: Using bolts and nuts to join components, allowing for disassembly.
- Screwing: Using screws to join lighter components or where clamping force is needed.
- Pinning: Inserting cylindrical pins into holes of joined parts to provide alignment or locking.

(b) Riveted joints are advantageous because they do not require heat, minimizing distortion of the base materials. They are simple to inspect and maintain. Riveted joints can be used in places where welding is impractical, such as in explosive environments. Additionally, riveted joints allow for flexibility under load, which can absorb vibrations.

(c) Nuts and bolts have disadvantages such as the tendency to loosen under vibration unless locking devices are used. They also require access from both sides of the assembly, which may not always be feasible.

(d) (i) Washer distributes the pressure of the nut or bolt head to prevent surface damage.
(ii) Nut provides the clamping force when tightened against the bolt.
(iii) Bolt acts as the fastener that holds the parts together.
(iv) Locking device prevents the nut from loosening under vibration or movement.

4. (a) Tapping is the process of cutting internal threads inside a drilled hole using a tap tool. It is a manual or machine process used to allow bolts or screws to be fitted into the hole.

(b) (i) A taper tap has a gentle cutting edge and is used to start threads easily. A plug tap has a more complete thread profile and is used to finish the threading process.
(ii) Precautions include aligning the tap perpendicularly to the hole to ensure accurate threads and applying cutting fluid to reduce friction and prevent tap breakage.

(c) The standard tap set sketch shows three taps: taper tap, second tap, and plug tap. The direction of rotation is clockwise for cutting right-hand threads.

(d) Causes of thread defects include using a dull or broken tap, applying too much force, poor alignment of the tap, lack of lubrication, and using incorrect tap size for the hole.

5. (a) Single point cutting tools have one cutting edge and are used in operations such as turning or shaping. Multipoint tools, like drills or milling cutters, have more than one cutting edge and remove material simultaneously from multiple points.

(b) During drilling, the twist drill cuts material by rotating while its two cutting lips shear away the material. The flutes of the drill remove the chips from the hole as the drill penetrates deeper.

(c) Three types of drilling machines include:

- Bench drill: Used for light-duty operations on small workpieces.
- Pillar drill: Has more power and is mounted on the floor for larger work.
- Radial drilling machine: Used for large and heavy workpieces as it allows the drill head to move

along a radial arm.

(d) Safety precautions include securing the workpiece firmly, wearing safety goggles, using the correct drill speed, removing chips with a brush (not hands), and ensuring the drill is sharp and not overheated.

6. (a) A lathe machine holds and rotates a workpiece while a cutting tool is fed into the work to perform operations like turning, facing, and threading. It allows precision shaping of cylindrical parts.

(b) Four parts of a centre lathe and their functions:

- Headstock: Contains the spindle and drive mechanism for rotating the workpiece.
- Tailstock: Holds tools like drills and supports the workpiece from the opposite end.
- Carriage: Moves the cutting tool along the bed and guides it during cutting.
- Bed: Provides a stable base and guides for the movement of carriage and tailstock.

(c) The procedures include mounting the workpiece in the chuck, selecting the correct cutting tool, setting appropriate speed and feed, adjusting tool position, and performing rough and finish cuts to reach desired diameter.

(d) Common faults include:

- Poor surface finish due to dull tool or incorrect speed.
- Tapered work due to misaligned tailstock.
- Tool chatter caused by loose setup or excessive overhang.
- Incorrect dimensions due to tool wear or inaccurate measurements.

7. (a) (i) Cutting fluid is a liquid applied during machining to cool the tool and workpiece, lubricate the cutting edge, and flush away chips.
(ii) Properties of a good cutting fluid include high thermal conductivity, non-toxicity, corrosion resistance, good lubrication properties, and stability under heat.

(b)
Cutting speed = $\pi \times D \times N / 1000$
= $3.142 \times 90 \times 500 / 1000$
= $14139 / 1000$
= 14.139 m/min

(c) Four factors include: the type of material to be cut, the required surface finish, the cutting speed and feed, and the type of machining operation.

(d)
Feed per minute = Feed/rev × Spindle speed
= 0.2 mm/rev × 250 rpm
= 50 mm/min

8. (a) Reconditioning a dull twist drill involves grinding the cutting edges evenly to the correct angles, removing any chip clogging in the flutes, and ensuring both lips are the same length to balance cutting forces.

(b) Causes of drill breakage include applying excessive pressure, using a dull or worn drill, improper alignment of the drill, and lack of cutting fluid. To avoid breakage, use sharp drills, proper speed, apply coolant, and align the tool accurately.

(c) (i) A jig is a device used to guide the drill to ensure holes are made accurately and consistently in repeated operations.
(ii) A drill jig guides the tool and holds the workpiece, while a fixture only holds the workpiece without guiding the tool.

(d) (i) Spot drilling creates a shallow hole to guide a larger drill bit and prevent walking.
(ii) Centre drilling provides a conical hole for starting a drill or to support turning between centres.