THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATION COUNCIL

DIPLOMA IN TECHNICAL EDUCATION EXAMINATION

789 METAL WORKING AND MECHANICAL PRACTICE

(SUPPLEMENTARY)

Time: 3 Hours. **ANSWER** **Year: 2004**

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) **Define the term 'reaming allowance' in a drilling operation.**

   Reaming allowance is the small extra material intentionally left in a drilled hole to be removed by a reamer in order to achieve an accurate size and smooth finish. It ensures that the final diameter after reaming is precise and free from irregularities.

   (ii) **Give two purposes of the 'land' on a twist drill bit.**

   The land on a twist drill bit serves two main purposes:

1. It guides the drill bit in the hole to maintain correct alignment.

2. It supports the cutting edges and prevents the drill from wobbling during drilling.

   (iii) **State four common causes for a rough or scored hole surface after a reaming operation.**

1. Using a reamer that is dull or worn out.

2. Feeding the reamer too quickly or with excessive pressure.

3. Inadequate lubrication during the reaming process.

4. Reaming a hole that is not properly drilled or has irregularities.

   (iv) **State two causes for a drill making an oversize hole.**

1. The drill is worn or has a large clearance angle.

2. Excessive speed or feed causing the drill to chatter.

   (b) **Describe the process of using a die stock to cut an external thread.**

   To cut an external thread using a die stock:

- Secure the workpiece in a vice ensuring it is held firmly and straight.

- Select the appropriate die and place it in the die stock.

- Apply cutting fluid to the workpiece to reduce friction and heat.

- Align the die with the end of the workpiece and start turning it clockwise by hand.
- Turn the die a few complete rotations, then reverse slightly to break the chips.
- Continue until the required thread length is cut, then remove the die and clean the threads.

(c) **State three common causes for a tap breaking during an internal threading operation.**

1. Using excessive force when turning the tap.
2. Tap is misaligned with the hole, causing uneven cutting.
3. Tap is dull or not lubricated properly, increasing resistance.

2. (a) (i) **Differentiate between an internal thread and an external thread.**

- An internal thread is a thread cut inside a hole, such as in a nut.
- An external thread is a thread cut on the outside of a cylindrical rod, such as on a bolt.

(ii) **Give an example of a tool used for each type of thread.**

- Internal thread: Tap.
- External thread: Die.

(iii) **Explain why the flutes on some reamers are cut with a left-hand helix.**
Flutes with a left-hand helix are used when the workpiece rotates clockwise, allowing the reamer to cut smoothly while reducing chatter and improving chip evacuation.

(b) **Explain the term 'threading' and give three requirements of correct threading.**
Threading is the process of cutting helical grooves on the external or internal surface of a workpiece to form a screw thread.
Requirements of correct threading:

1. Correct pitch and depth according to thread standard.

2. Smooth surface finish without burrs.

3. Accurate alignment and straightness of the thread axis.

(c) **State four requirements for a good tapping fluid (lubricant).**

1. Reduces friction between the tap and the workpiece.

2. Cools the tap to prevent overheating.

3. Prevents chip welding to the tap.

4. Protects both the tap and the workpiece from corrosion.

3. (a) **How can the drilling of large diameters in sheet metal be done satisfactorily?**
   Drilling large diameters in sheet metal can be done by first making a smaller pilot hole, then gradually enlarging it with progressively larger drill bits. This reduces stress, prevents deformation, and improves accuracy.

(b) **Explain the importance of using a drill drift when removing a taper shank drill bit from the spindle.**
A drill drift ensures the safe removal of a taper shank drill from the machine spindle without damaging the spindle or the drill. It helps apply force evenly along the taper.

(c) **Give the purpose for each of the following in metal works:**
(i) **Counterbore tool pilot:** Guides the counterbore tool to maintain alignment and ensure a centered larger hole.
(ii) **Chamfer:** Creates a beveled edge at the entrance of a hole to ease assembly and remove sharp edges.

4. (a) **Explain the concept of 'pitch circle diameter (PCD)' as applied to flange drilling or gear measurement.**
   PCD is the diameter of an imaginary circle that passes through the centers of all the bolt holes or gear teeth. It is used to determine the correct spacing for holes or teeth to ensure proper alignment and fit.

   (b) **Define the terms 'minor diameter' and 'major diameter' for an external screw thread.**

- Minor diameter: The diameter of the root of the thread (smallest diameter).
- Major diameter: The diameter of the crest of the thread (largest diameter).

   (c) **Explain the principle behind using a mandrel (or arbor) in a lathe operation.**
   A mandrel supports the workpiece internally, allowing it to rotate accurately around its axis while machining, ensuring concentricity and minimizing deflection.

5. (a) **Draw a flat chisel in a cutting position and show its important geometry angles.**
   A flat chisel has a cutting edge with clearance angles such as the **bevel angle** (typically 60°–70°) and **side clearance** (about 5°–10°). The tool is positioned so that the cutting edge engages the workpiece effectively.

   (b) **Outline the requirements for laying out lines using a surface gauge or a vernier height gauge.**

- The tool must be placed on a flat and clean surface.
- The scriber should be sharp and properly adjusted to the required height.
- Movements should be steady to ensure accurate marking.
- Measurements should be checked against a standard or scale.

   (c) **State three functions of the headstock in a centre lathe.**

1. Supports and rotates the spindle and workpiece.

2. Provides power through gear trains or belts.

3. Houses change gears for threading and speed control.

6. (a) **Explain the term 'cutting speed' as used in workshop practice.**
   Cutting speed is the speed at which the cutting tool engages the workpiece surface, usually expressed in meters per minute (m/min). It affects tool life, surface finish, and machining efficiency.

   (b) (i) **Outline the factors that limit the use of the maximum feed to the workshop machine.**

- Material hardness and toughness.
- Tool geometry and condition.
- Machine rigidity and stability.
- Type of operation being performed.

   (ii) **Write two purposes of reamers with left-hand helix.**

1. Improve chip evacuation when rotating clockwise.

2. Reduce chatter and vibration during reaming.

   (c) **What are the two main purposes of the flutes on a twist drill?**

1. Provide a cutting edge along the spiral.

2. Remove chips from the hole efficiently during drilling.

7. (a) **Outline four safety precautions specific to using a portable electric hand drill.**

8. Wear safety goggles and protective clothing.

9. Ensure the drill bit is securely fixed before operation.

10. Keep hands and loose clothing away from the rotating bit.

11. Disconnect power before changing bits or making adjustments.

(b) **Differentiate between a die and a tap in terms of their function.**

- Die: Used to cut external threads on a rod or bolt.
- Tap: Used to cut internal threads inside a hole.

(c) **State three advantages of using a three-jaw self-centering chuck over a four-jaw independent chuck.**

1. Automatically centers the workpiece for faster setup.

2. Easier to operate with less skill required.

3. Provides uniform gripping on cylindrical stock.

8. (a) **Calculate the change gears to cut a Right-Hand (R.H.) thread of 10 T.P.I. on a lathe with a lead screw pitch of 4 T.P.I.**
   Using the formula:

Change Gear Ratio = (Lead Screw T.P.I.) / (Thread T.P.I.) = 4 / 10 = 0.4

So, a combination of gears giving a 0.4 ratio should be used to cut the 10 T.P.I. thread.

(b) **Calculate the cutting speed given that the work diameter is 14 mm and the rotation speed (N) is 8 rev/min. Use $\pi = 3.142$.**

Cutting speed $V=\pi \times D \times N/1000$ V = \pi \times D \times N / 1000 in m/min

V = 3.142 × 14 × 8 / 1000 = 0.351 m/min

(c) **What is the pitch, depth, and minor diameter for an M6 × 1.0 thread? Given: Pitch (P) = 1.0 mm and Depth = 0.6134 × P.**

- Pitch = 1.0 mm
- Depth = 0.6134 × 1.0 = 0.613 mm
- Minor diameter = Major diameter − 2 × Depth = 6 − 2 × 0.613 = 6 − 1.226 = 4.774 mm