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: 2012**

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) Reaming is a machining process used to slightly enlarge and smoothen a previously drilled hole to an accurate size and fine surface finish. It is typically done after drilling to ensure dimensional precision and circularity of the hole.

   (b) (i) A reamer is designed to remove small amounts of material for fine sizing, while a drill bit is meant to create a hole by removing more material rapidly. Reamers have straight or helical flutes for precise cutting, whereas drill bits have spiral flutes for quick material removal.
   (ii) A hand reamer is used manually for finishing holes in assembly jobs, while a machine reamer is used in drill presses or lathes for high-precision work.

   (c) To ream a hole, first drill it slightly smaller than the desired final diameter. Select a suitable reamer and apply lubrication. Insert the reamer into the hole, turning it slowly and steadily with even pressure. Withdraw the reamer carefully after reaching full depth to avoid damaging the surface.

   (d) Always ensure the hole is properly drilled before reaming. Use appropriate cutting fluid to reduce friction. Turn the reamer slowly and do not reverse while in the hole to prevent chipping. Support the workpiece firmly to avoid vibrations that could cause inaccurate results.

2. (a) Heat treatment is a controlled process of heating and cooling metals to alter their physical and mechanical properties. It is used to increase hardness, relieve stresses, improve ductility, or refine grain structure.

   (b) (i) The four common types are annealing, hardening, tempering, and normalizing.
   (ii) Annealing softens metal and improves machinability. Hardening increases strength and wear resistance. Tempering reduces brittleness after hardening while maintaining hardness. Normalizing refines grain structure and improves toughness.

   (c) After heat treatment, metals can become harder or softer depending on the process used. Internal stresses may be reduced, leading to improved dimensional stability. Grain structure changes, resulting in better toughness or strength.

   (d) Use protective gloves and goggles to avoid burns. Ensure the metal is clean before heating. Control temperature and cooling rates accurately to prevent cracking. Keep flammable materials away from the heat source.

3. (a) The lathe tailstock is a movable component located on the opposite side of the headstock. It supports long workpieces and holds tools like drills or reamers for operations performed along the lathe axis.

(b) (i) The tailstock is used in centre drilling and drilling operations.
(ii) To adjust it, align the tailstock with the spindle center, clamp it in place, and move the quill forward or backward using the handwheel to position the tool correctly.

(c) In taper turning by offset method, the tailstock is slightly shifted from its aligned position. The workpiece is mounted between centers, and as the lathe rotates, the tool moves parallel to the lathe bed while the offset creates a taper on the rotating workpiece.

(d) Inaccuracies may occur due to improper tailstock alignment, incorrect offset measurement, uneven tool feed, or vibrations during cutting.

4. (a) Squaring is the process of making adjacent surfaces of a workpiece form a precise 90-degree angle. It ensures accuracy in assembly and proper alignment in fabrication.

(b) (i) Tools used include the engineer's square, surface plate, and scriber.
(ii) To check squareness, place the workpiece against a surface plate and use the engineer's square. Any gap between the square and the surface indicates inaccuracy.

(c) Squaring is essential in preparing base surfaces for assembly in frames or box structures. It is also used in marking out work to ensure accurate fitting or machining.

(d) Errors occur due to worn tools, inaccurate markings, or improper clamping. These can be avoided by calibrating tools, double-checking measurements, and securing workpieces firmly during filing or machining.

5. (a) Thread pitch is the distance between corresponding points on adjacent threads. It is measured from crest to crest or root to root in millimetres for metric threads.

(b) (i) The number of threads per inch (TPI) is the reciprocal of the pitch in imperial threads. As the pitch increases, TPI decreases, and vice versa.
(ii) A pitch gauge is placed against the threads. The blade that fits the groove snugly without gaps gives the correct pitch value.

(c) Incorrect thread pitch results in mismatched components, leading to loose fits, stripped threads, or failure to assemble. It compromises joint integrity and can cause mechanical failure under load.

(d) Common defects include thread burrs caused by worn tools, double threads from incorrect tool alignment, flattened threads from excessive force, and incorrect pitch from using wrong settings or dies.

6. (a) A coolant is a fluid used during machining to reduce heat generated by friction and to flush away chips. It also prolongs tool life and improves surface finish.

(b) (i) Types of coolants include water-based fluids, cutting oils, and synthetic coolants.
(ii) Water-based coolants offer excellent heat removal. Cutting oils provide lubrication and reduce tool wear. Synthetic coolants offer balanced cooling and lubricating properties.

(c) Coolants reduce the temperature at the cutting edge, preventing tool damage. They wash away chips that could cause scratches. They also reduce friction, allowing smoother cutting and better dimensional accuracy.

(d) Improper use can result in skin irritation, especially from oil mist. Inhalation of vapour may cause respiratory issues. Slippery floors near machines can cause accidents. Used coolant may become contaminated and hazardous if not disposed of properly.

7. (a) Mechanical fastening is a joining method that uses physical devices like bolts, nuts, screws, and rivets to hold parts together. Examples include bolted joints and screwed fittings.

(b) (i) Mechanical fasteners allow disassembly for maintenance. They do not introduce heat, avoiding distortion. They are quick to apply and require less training.
(ii) Limitations include loosening under vibration and requiring holes, which may weaken the structure. Also, they are not airtight or watertight without sealing.

(c) First align the parts to be joined. Insert the bolt through the aligned holes. Place a washer and thread the nut onto the bolt. Tighten the nut using a spanner to ensure firm contact. Ensure all fasteners are evenly tightened.

(d) Failure may occur due to vibration-induced loosening, corrosion weakening the material, over-tightening causing thread stripping, or improper size selection leading to shear failure.

8. (a) A bench vice is a clamping device fixed on a workbench, used to hold metal workpieces securely during cutting, filing, or drilling. It allows precision and stability.

(b) (i) The plain jaws are flat-faced and grip general workpieces. Serrated jaws have ridges for better grip on round or irregular items.
(ii) Clean the jaws and screw thread regularly. Lubricate the moving parts to prevent rust and ensure smooth operation.

(c) If the workpiece is clamped too tightly, it may deform, especially softer metals. Misalignment between jaws and the workpiece can also cause slipping or uneven surfaces during filing.

(d) Always clamp the workpiece fully between the jaws. Do not use the vice handle as a lever or hammer. Keep fingers clear when tightening. Ensure the vice is securely bolted to the bench to prevent tipping.