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: 2013**

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) A lathe chuck is a clamping device mounted on the spindle of a lathe used to hold and rotate the workpiece during machining. It ensures that the workpiece is securely gripped and centered for operations like turning, facing, and boring.

   (b) (i) Two types of lathe chucks are the three-jaw chuck and the four-jaw independent chuck.
   (ii) The three-jaw chuck is self-centering, which makes it convenient and quick for gripping round or hexagonal workpieces. The four-jaw chuck allows independent adjustment of each jaw, enabling the clamping of irregular shapes or precise centering of workpieces.

   (c) To mount a workpiece using a three-jaw chuck, first ensure the chuck jaws are clean. Place the workpiece between the jaws and rotate the chuck key evenly until the workpiece is gripped securely. Check for centering by rotating the chuck manually. Tighten further if necessary and remove the chuck key before starting the machine.

   (d) Never leave the chuck key in the chuck to avoid accidents. Always ensure the workpiece is tightly clamped before starting. Avoid operating the machine at high speed if the workpiece is off-center. Regularly inspect and clean the chuck jaws to maintain proper grip and accuracy.

2. (a) A keyway is a slot or recess cut into a shaft or hub that accommodates a key. The key prevents relative motion between the shaft and the mating component like gears or pulleys, allowing torque transmission.

   (b) (i) Methods used to cut keyways include broaching, slot milling, and shaping.
   (ii) Broaching provides accurate keyways with smooth surfaces. Slot milling is flexible and suitable for various sizes. Shaping is cost-effective for short production runs.

   (c) Keyways allow positive mechanical engagement between a rotating shaft and the component it drives. This prevents slippage and ensures that the rotation and torque of the shaft are transferred efficiently.

   (d) Causes of failure in keyway joints include incorrect fit between key and keyway, use of soft materials leading to deformation, improper alignment causing uneven load distribution, and excessive torque beyond design capacity.

3. (a) A machine vice is a clamping tool used to hold workpieces rigidly on machines such as drilling or milling machines. It ensures the workpiece remains stable during cutting operations.

(b) (i) Machine vices are used to hold workpieces during drilling, milling, and surface grinding operations.
(ii) Unlike bench vices which are manually operated and fixed on benches, machine vices are precision devices mounted on machine tables and used with powered tools for accurate machining.

(c) Mount the vice on the machine table and align it with the machine axis using a dial indicator. Use T-bolts or clamps to secure the vice through its base slots. Ensure the base is clean to avoid misalignment and check squareness before starting the operation.

(d) Regularly clean the vice to remove metal chips and coolant. Lubricate the screw threads and moving parts. Tighten bolts and fasteners to prevent vibration. Avoid clamping irregular shapes without proper support.

4. (a) Arc blow is the deflection of the welding arc away from its intended path due to magnetic interference. It results in poor control of the arc and inconsistent weld quality.

(b) (i) Two types of arc blow are magnetic arc blow and thermal arc blow.
(ii) To prevent arc blow, weld away from the earth clamp to reduce magnetic interference. Use alternating current (AC) instead of direct current (DC), or reduce welding current.

(c) Arc blow leads to unstable arc movement, causing weld defects like porosity, uneven beads, and undercutting. It makes it difficult to maintain a steady weld pool and can result in weak joints.

(d) Welding positions include flat position used for structural plates, horizontal position common in pipe welding, vertical position for welding up or down walls, and overhead position used in ceiling or upper surface welds.

5. (a) A bore gauge is a precision measuring instrument used to determine the internal diameter of holes or cylinders with high accuracy.

(b) (i) A telescopic gauge is used in conjunction with an external micrometer and requires manual feel for measurement. A dial bore gauge gives direct readings and uses a dial indicator to measure variation from a preset size.
(ii) Telescopic gauges are simple and affordable. Dial bore gauges offer quick and accurate readings with minimal user error.

(c) Insert the gauge into the bore and align it squarely. Gently rock the gauge to find the point of minimum reading. Lock the gauge at this position and remove it. Measure the dimension using an external micrometer or read directly if using a dial bore gauge.

(d) Inaccuracies may arise from improper alignment of the gauge, worn-out contact points, thermal expansion of the workpiece, or incorrect zero setting of the gauge.

6. (a) Reamer runout refers to the deviation of the reamer's cutting edge from its true axis of rotation, causing an uneven or oversized hole.

(b) (i) Causes of runout include worn machine spindles, misalignment of the tool holder, or using a bent or damaged reamer.
(ii) Excessive runout leads to oversized holes and poor surface finish, and may cause vibration or tool chatter during operation.

(c) To reduce reamer runout, ensure the reamer is properly mounted and aligned. Use a floating reamer holder to compensate for minor misalignments. Keep the machine spindle and holder in good condition.

(d) A good reamer should be made of high-speed steel or carbide. It should have a straight or spiral flute for chip removal. It should maintain dimensional accuracy and have high wear resistance.

7. (a) Die threading is a process of cutting external threads on cylindrical workpieces using a die. It is commonly done on rods, shafts, or bolts.

(b) (i) Types of dies include split dies and solid dies.
(ii) A split die is held in a die holder with screws to adjust the diameter slightly. A solid die is fixed and requires a specific holder for threading.

(c) After threading, the external thread is checked using a thread gauge or mating nut. The thread should fit smoothly without excessive play or tightness, and should be free from burrs or damage.

(d) Thread failure may result from using dull or worn dies, applying excessive pressure during cutting, poor alignment, or using incorrect die size for the material.

8. (a) Back gear is a gear mechanism in a centre lathe that allows the spindle to run at slower speeds, increasing torque for heavy cutting operations.

(b) (i) The back gear reduces spindle speed, making it suitable for operations that require more torque, such as large-diameter turning or threading.
(ii) It should be used when cutting large workpieces or using large diameter tools, and when fine surface finish is required at low speeds.

(c) To engage the back gear, first disengage the bull gear by pulling out the locking pin on the cone pulley. Then engage the back gear by shifting the back gear lever. This redirects the drive through the gear train, reducing speed.

(d) Improper use may lead to gear damage due to incomplete engagement. Overloading at slow speed may stress the motor. Poor lubrication can cause wear and noise. Operating with loose belts or gears can reduce accuracy and lead to vibration.