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: 2006**

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) Chipping is a metal cutting process performed manually using a hammer and chisel to remove excess material or shape a workpiece. It is commonly used to smooth, level, or prepare metal surfaces before machining.

(b) A cold chisel is used to cut rivet heads when dismantling assembled components. It is also applied to chip away metal burrs after drilling. It helps in removing rust or scale from metal surfaces. Additionally, it is used in cutting grooves or channels on metal plates.

(c) (i) To chip a flat surface, first secure the workpiece firmly in a vice. Hold the flat chisel at a proper angle, typically 30 degrees to the surface. Using a ball peen hammer, strike the chisel with controlled force to shear off thin metal layers. Maintain consistent pressure and overlap each stroke slightly until the desired surface is achieved.
(ii) When using a cold chisel, always wear safety goggles to protect eyes from flying chips. Hold the chisel firmly to prevent slipping. Ensure the chisel edge is sharp and not mushroomed to maintain control and avoid accidents.

(d) Chipping allows for shaping irregular surfaces or places that cannot be accessed by machines, making it more versatile for fieldwork. It also requires minimal equipment. However, it is less precise compared to sawing and can leave rough finishes. It is also slower and more physically demanding.

2. (a) A hand tap is a tool used to cut internal screw threads in a previously drilled hole. It is commonly made of hardened steel and comes in sets for different threading stages.

(b) (i) The taper tap starts the thread and is used to initiate cutting. The second tap continues the thread to full depth. The plug tap finishes the thread to the required profile and smoothness.
(ii) Lubrication reduces friction during tapping, preventing tool wear and breakage. It also helps to flush out chips from the hole, improving thread quality.

(c) To align a tap properly, first position it perpendicularly to the hole surface using a tap wrench. Apply gentle pressure to start the threading straight. Rotate the tap clockwise two turns, then back it off half a turn to break chips. Continue with consistent feed while checking alignment throughout the process.

(d) If the tap is misaligned, it may cut uneven or shallow threads. It can also bind in the hole and break, damaging the workpiece. Additionally, misaligned threads may prevent bolts from fitting properly, leading to assembly failure.

3. (a) Cutting speed is the rate at which the cutting tool moves past the material being machined, typically measured in meters per minute. It depends on the material being machined and the type of tool used.

(b) (i) Cutting speed = $\pi \times$ Diameter $\times$ RPM / 1000
= $3.142 \times 30 \times 600 / 1000$
= 56.556 m/min
(ii) Cutting speed depends on the type of material being machined, as harder materials require slower speeds. It also depends on the tool material, since high-speed tools can tolerate higher speeds than standard ones.

(c) Using a speed that is too high can cause the cutting tool to overheat, leading to rapid wear or failure. It may also damage the surface finish of the workpiece and cause dimensional inaccuracies due to thermal expansion.

(d) Correct cutting speed ensures smooth surface finish, increases tool life by reducing wear, and maintains consistent dimensional accuracy. It also reduces power consumption and improves machining efficiency.

4. (a) Arc blow is the deflection of the welding arc from its intended path due to magnetic forces. It is commonly observed in DC welding and affects weld quality.

(b) (i) Arc blow can be caused by improper grounding of the workpiece. Excessive welding current generates strong magnetic fields that deflect the arc. It can also occur when welding near the edge of a plate or in corners where magnetic fields concentrate.
(ii) Reducing arc blow can be done by repositioning the ground clamp closer to the weld area. Using a back-step welding technique can help minimize magnetic field buildup.

(c) Arc blow results in unstable arc movement, leading to poor weld bead appearance. It causes slag entrapment due to irregular arc flow. It can also lead to incomplete fusion between the base metal and the filler.

(d) Wear a proper welding helmet to protect eyes from arc rays. Use insulated gloves and boots to avoid electric shock. Ensure the welding machine is in good condition. Avoid welding in damp or wet conditions to reduce the risk of electrocution.

5. (a) A machine tool is a powered mechanical device used to shape or fabricate metal by removing unwanted material. Examples include the lathe machine and the milling machine.

(b) (i) A lathe machine is used for turning cylindrical workpieces. It can perform facing operations to create flat surfaces. It is also used for threading to produce internal and external threads.
(ii) A shaper uses a single-point cutting tool moving in a linear motion, while a slotter also uses a linear motion but is specifically for cutting slots and keyways. A shaper generally works horizontally, while a slotter works vertically.

(c) A milling machine rotates a multi-tooth cutter against a stationary or moving workpiece. The cutting edges remove material as the workpiece feeds through the cutter. It is used for shaping flat, contoured, or irregular surfaces.

(d) Always ensure all guards are in place before starting the machine. Wear appropriate personal protective equipment. Do not leave the machine unattended while running. Avoid reaching over moving parts or adjusting tools while in operation.

6. (a) A scraper is a hand tool used in metal fitting to remove high spots and improve the flatness of mating surfaces. It refines the surface by shaving off minute material layers.

(b) (i) A flat scraper has a straight cutting edge and is used on broad, flat surfaces. A triangular scraper has three cutting edges and is suited for working on grooves or small areas.
(ii) A half-round scraper is used for scraping concave surfaces such as bearing housings or internal curves.

(c) To hand scrape a flat surface, the workpiece is coated with a marking compound. The surface is placed against a reference plate to identify high spots. The scraper is then used to remove the highlighted spots. This process is repeated until an even contact pattern is achieved.

(d) A properly scraped surface shows a uniform pattern of small bearing points. It has good flatness and contact with the mating surface. The finish is matte and free of tool marks. It provides excellent oil retention for lubrication.

7. (a) A feeler gauge is a measuring tool consisting of a set of thin metal strips of varying thickness. It is used to check clearances or gaps between two parts, such as between a valve and its seat.

(b) (i) Types of gauges include plug gauges used to check hole dimensions, ring gauges to verify shaft sizes, and snap gauges to inspect external dimensions.
(ii) A plug gauge is inserted into a hole to check if it falls within acceptable limits. It provides a quick pass/fail inspection without requiring precise measurement.

(c) Gauges provide faster inspection than traditional measuring tools. They reduce operator error by giving clear pass/fail results. They are also useful in mass production where quick checks are needed without stopping the workflow.

(d) Gauges cannot measure exact dimensions; they only indicate whether a part is within limits. They are also specific to one size or tolerance range and cannot be adjusted for other dimensions.

8. (a) Annealing is a heat treatment process that involves heating a metal to a specified temperature, holding it there, and then cooling it slowly. It is done to soften the metal, relieve internal stresses, and improve machinability.

(b) (i) Annealing reduces hardness and increases ductility, making the metal easier to shape. It relieves internal stresses caused by prior machining or forming. It refines the grain structure for better mechanical properties.
(ii) Full annealing involves heating to above the critical temperature and cooling slowly, usually in a furnace. Stress-relieving annealing involves lower temperatures and shorter holding times to relieve internal stresses without significant changes in hardness.

(c) To anneal a medium carbon steel bar, heat it uniformly to around 850°C until it reaches a red-hot state. Hold it at that temperature for a specified period depending on the size. Then allow it to cool slowly in a furnace or cover it with insulating material like sand to control the cooling rate.

(d) Applying heat unevenly can cause warping or distortion. Overheating may result in grain growth and reduce strength. Rapid cooling may not relieve stress effectively and could cause cracking. Prolonged exposure to heat can also cause oxidation or decarburization.