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: 2005**

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).

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1. (a) Tolerance in mechanical measurement refers to the permissible limit or variation in the dimensions of a manufactured part. It specifies the range within which a part's size can deviate from its nominal dimension and still be acceptable for proper function.

(b) (i) Tolerances are important because they ensure that mating parts fit together properly even when manufactured separately. They allow for variations in production processes without compromising the functionality of the final assembly.
(ii) Poor tolerance control can lead to parts not fitting together, causing assembly delays. It can result in excessive wear due to loose fits or jamming from overly tight fits. Additionally, it increases the rejection rate and cost of manufacturing due to rework or scrap.

(c) Four types of fit used in mechanical engineering include clearance fit, which allows for free movement between mating parts; interference fit, which requires force to assemble parts due to overlapping dimensions; transition fit, which may result in either slight clearance or interference; and push fit, where parts can be assembled by hand but stay firmly in place.

(d) Limits and fits relate to interchangeability because they ensure that parts produced by different manufacturers can fit and function together without custom adjustments. Proper specification of limits and fits allows standardized mass production and easy replacement of components.

2. (a) A hacksaw blade is a thin, flat, toothed metal strip mounted in a hacksaw frame used for cutting metal by hand. It is commonly used in the workshop to saw rods, pipes, and sheet metal.

(b) (i) High-speed steel (HSS) blades are used for cutting hard metals and remain sharp for longer. Carbon steel blades are suitable for cutting softer metals such as aluminum and copper.
(ii) Hacksaw blades should be stored in dry places to avoid rusting. They should also be kept in cases or sleeves to prevent teeth damage or accidental injury.

(c) Inaccurate cuts with a hand hacksaw can result from a loose blade in the frame, causing it to flex or shift during sawing. Using a worn-out blade reduces cutting efficiency and control. Applying uneven pressure or sawing at an angle also leads to uneven or crooked cuts.

(d) To maintain accuracy when sawing manually, the blade must be tightly secured and correctly positioned. The workpiece should be firmly clamped to prevent movement. Consistent forward strokes with light return motion ensure smooth cutting. Using the appropriate blade for the material type also improves accuracy.

3. (a) Ferrous metals are those that contain iron as their main component, such as steel and cast iron. Non-ferrous metals do not contain significant amounts of iron, such as aluminum, copper, and brass. The main difference lies in their magnetic properties and resistance to rust.

(b) Aluminum is lightweight and used in aircraft structures. Copper has high electrical conductivity and is used in wiring. Brass is corrosion-resistant and used in plumbing fittings. Zinc is used for galvanizing steel to protect against rust.

(c) (i) Non-ferrous metals are preferred in many cases because they resist corrosion better than ferrous metals. They are lighter, making them ideal for weight-sensitive applications. They also have unique properties such as high electrical or thermal conductivity.
(ii) Ferrous metals are heavy, making them unsuitable for weight-sensitive designs. They are also more prone to corrosion unless treated or alloyed.

(d) A metal alloy is a combination of two or more elements, where at least one is a metal, used to enhance properties like strength, corrosion resistance, or workability. Examples include stainless steel, which is an alloy of iron and chromium, and bronze, which is made of copper and tin.

4. (a) A screw thread is a helical ridge wrapped around a cylindrical surface. It is used to convert rotary motion into linear motion or to fasten objects together. It forms the basis of bolts, screws, and nuts.

(b) Metric threads are measured in millimeters and follow international standards like ISO. Imperial threads are measured in inches and often follow Unified Thread Standards (UTS) or British Standard Whitworth (BSW). Their pitch and form vary accordingly.

(c) (i) Pitch is the distance between corresponding points on adjacent threads.
(ii) Crest is the top surface of the thread.
(iii) Root is the bottom part between two adjacent threads.
(iv) Major diameter is the largest diameter of the thread measured from crest to crest.

(d) Threading defects include poor alignment of the tool or die, which causes uneven threads. Incorrect feed rate or cutting speed may lead to tearing of the thread. Dull tools produce rough threads. Lack of cutting fluid causes overheating and damaged thread surfaces. Solutions include using guides, setting correct machine parameters, sharpening tools, and applying lubricants.

5. (a) Welding distortion is the unwanted deformation of a metal workpiece caused by uneven heating and cooling during the welding process. It usually results from contraction stresses as the weld cools faster than surrounding areas.

(b) (i) Methods to control distortion include clamping the workpiece firmly to restrict movement. Using tack welds to hold pieces in position during welding helps distribute heat. Welding in a balanced manner by alternating sides reduces concentrated heat buildup.
(ii) Ignoring distortion can lead to parts that do not fit in assemblies. It may also cause residual stresses that lead to cracks or fatigue failure during service.

(c) An intermittent weld consists of spaced welds along the joint, used where full strength is not required. A continuous weld is unbroken along the entire joint, providing maximum strength and a better seal against fluids.

(d) Weld inspection ensures that the welds are free of cracks, porosity, or inclusions. It verifies the joint strength and load-bearing capability. Inspection helps meet quality standards and prevents failure during operation. It also ensures compliance with engineering and safety specifications.

6. (a) Riveting is a method of permanently joining two or more metal pieces using metal pins called rivets. The rivet is inserted through holes in the workpieces and deformed at one or both ends to hold the materials together. Common types include solid rivets and pop rivets.

(b) (i) Hand riveting involves drilling or punching holes in the pieces to be joined. A rivet is inserted into the hole. A bucking bar or anvil is held against one end while the other end is hammered or squeezed to form a head. The rivet is then checked for tightness and finish.
(ii) Riveting produces no heat, reducing thermal distortion. It is ideal for thin sheet metals and allows quick manual assembly without specialized equipment.

(c) A rivet set is a tool used to shape the head of the rivet during installation. A hammer is used to strike the rivet set or directly peen the rivet end. Both tools are essential for forming and securing the rivet joint.

(d) Riveted joints may fail due to improper hole alignment, which leads to shear or tension failure. Over-tightening can crack the rivet or distort the workpiece. Corrosion at the joint reduces strength. Vibration can loosen rivets over time if not properly set.

7. (a) Machine maintenance is the regular servicing and care of mechanical equipment to ensure it operates efficiently, safely, and with minimal downtime. It includes inspection, lubrication, cleaning, and replacement of worn parts.

(b) Types of maintenance include preventive maintenance, where machines are serviced before problems occur. Corrective maintenance involves fixing faults once detected. Predictive maintenance uses sensors and diagnostics to forecast failures. Emergency maintenance is carried out immediately after breakdowns.

(c) (i) Neglecting routine maintenance can result in unexpected machine failure and production delays. It increases wear on components, leading to higher repair costs.
(ii) Daily checks on a lathe include inspecting oil levels and ensuring lubrication points are filled. The alignment of the tailstock and tool post should also be checked for proper operation.

(d) During machine maintenance, ensure the machine is powered off and locked out. Use proper tools and follow manufacturer guidelines. Wear protective gear to avoid injury from sharp parts, hot surfaces, or accidental movements.

8. (a) Tool wear is the gradual loss of material from the cutting edge of a tool due to friction, heat, and mechanical forces during machining. It affects the efficiency, accuracy, and surface finish of the workpiece.

(b) (i) Types of tool wear include flank wear, which occurs on the side of the cutting edge due to abrasion. Crater wear forms on the rake face from chip contact. Built-up edge is caused by material sticking to the tool.
(ii) Reducing tool wear can be done by using appropriate cutting fluid to cool and lubricate the process. Using harder or coated cutting tool materials also extends tool life.

(c) In high-speed machining, selecting tool materials such as tungsten carbide, ceramic, or coated high-speed steel ensures that the tools withstand high temperatures and maintain their cutting edge longer. Material choice directly affects the performance and durability of the tool.

(d) Symptoms of a worn cutting tool include poor surface finish with visible marks, increased cutting force or vibration, irregular dimensions in the workpiece, and unusual noise during machining. Replacement should be done before the tool causes damage or failure.

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