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: 2011**

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) Standardization in mechanical production refers to the process of establishing common specifications and procedures for manufacturing components and using tools. This ensures compatibility, uniformity, and interchangeability of parts across various machines or systems.

   (b) (i) Standardizing machine components reduces production time because parts do not require custom machining. It allows easy replacement of worn or damaged parts since standard parts are readily available. It also facilitates mass production and simplifies assembly processes.
   (ii) Poor standardization results in mismatched parts that do not fit or function properly. It increases production cost due to the need for custom fabrication or adjustments.

   (c) Standard threads such as M10 or M12 ensure that bolts and nuts from different manufacturers can be used interchangeably. This uniformity simplifies repair and maintenance work and allows industries to source parts globally without compatibility issues.

   (d) International standards used in mechanical engineering include ISO (International Organization for Standardization), ANSI (American National Standards Institute), DIN (German Institute for Standardization), and BS (British Standards).

2. (a) Tapping drill size is the diameter of the hole that must be drilled before tapping a thread. It ensures there is sufficient material for the thread to be cut properly without making the hole too tight or too loose.

   (b) (i) The formula for calculating tapping drill size for metric threads is:
   Tapping drill size = Major diameter - Pitch
   (ii) For M12 × 1.75 thread:
   Tapping drill size = 12 - 1.75 = 10.25 mm

   (c) Using a drill size that is too small results in difficult tapping and may break the tap. Using a size that is too large leads to weak threads that do not hold properly. Both cases compromise the integrity of the assembly.

   (d) Ensure the hole is drilled straight and to the correct diameter. Use cutting fluid to reduce friction and avoid overheating. Align the tap properly to avoid miscut threads. Rotate the tap carefully and back off regularly to clear chips.

3. (a) Swarf refers to the waste chips or shavings produced when metal is cut, filed, drilled, or machined. It is commonly found in fitting, turning, milling, and drilling operations.

(b) (i) Types of swarf include spiral swarf formed in turning, needle swarf from drilling, and powder swarf generated in grinding.
(ii) Swarf can be sharp and cause cuts to hands or eyes. Accumulated swarf on the floor poses slipping hazards and fire risks, especially if it's oily.

(c) Swarf should be collected using brushes or tongs, not bare hands. Place swarf in designated bins marked for metal waste. Compact and segregate according to metal type for recycling. Dispose of hazardous swarf like oily chips separately under safety protocols.

(d) Safety goggles protect the eyes from flying chips. Industrial gloves protect hands when removing or handling swarf, especially sharp or hot pieces.

4. (a) Soldering flux is a chemical substance applied to metal surfaces before soldering to clean oxides and improve the flow of molten solder. It ensures strong and reliable joints.

(b) (i) Types of flux include rosin flux used in electronics, acid flux used in plumbing, and water-soluble flux used in general metal joining.
(ii) Flux removes oxidation from the metal surface, ensuring proper adhesion. It also prevents re-oxidation during heating, which would weaken the joint.

(c) Clean the metal surfaces before applying flux. Apply a small amount of flux evenly on the joint area. Heat the joint with the soldering iron and allow the flux to activate. Add solder as the flux begins to melt, then remove the heat and allow cooling.

(d) Use flux in a well-ventilated area to avoid inhaling fumes. Avoid direct skin contact with acidic flux. Use only the amount necessary to avoid residue. Clean off residual flux after soldering, especially in electrical work, to prevent corrosion.

5. (a) Tolerance grade refers to the permissible variation in the size or dimension of a manufactured component. It determines how much a dimension may deviate from the nominal value.

(b) (i) IT6 is a tight tolerance used in precision shafts. IT9 is used for medium fits like gears and pulleys. IT11 is used for general purpose fits where precision is not critical.
(ii) Tighter tolerance grades require more precise machining and inspection, increasing cost. Looser grades reduce cost but may affect performance or fit.

(c) Unilateral tolerance allows variation in only one direction from the nominal size (e.g., +0.00 / -0.05 mm). Bilateral tolerance allows variation in both directions (e.g., ±0.025 mm).

(d) Gears and bearings require tight tolerances to ensure proper alignment and performance. Shafts that fit into high-speed rotating assemblies also need tight tolerances to prevent vibration or imbalance.

6. (a) A die holder is a tool used to hold and turn a die during external threading. It ensures the die remains stable and aligned while cutting threads on cylindrical workpieces.

(b) (i) Types include T-handle die holders for small threads, adjustable round die holders for general use, and die stocks with long handles for larger threads.
(ii) Consider the size of the die to be used and the accessibility of the workspace. Also, ensure the holder matches the die shape (round or hexagonal).

(c) Clamp the workpiece securely and file a slight chamfer on the end. Place the die in the holder and align it squarely to the workpiece. Apply lubricant, then rotate the holder clockwise with firm pressure. After a few turns, reverse slightly to break chips and continue cutting.

(d) Damage to dies may result from using worn-out or dull dies, excessive pressure during threading, misalignment between die and workpiece, or lack of lubrication during operation.

7. (a) A drilling machine spindle is the rotating shaft that holds and drives the drill bit. It is a key component that transfers motion and torque from the motor to the cutting tool.

(b) (i) The spindle rotates the drill bit. It supports axial feed motion for cutting. It holds the chuck or taper sleeve for tool attachment.
(ii) Spindles are typically made from alloy steel or case-hardened carbon steel for strength and durability.

(c) Spindle misalignment is checked by drilling a hole and measuring its angular or positional deviation from the intended path. A dial indicator may also be used to check lateral movement or wobble.

(d) Misalignment causes oversized or off-center holes. It increases tool wear due to uneven load. Poor surface finish results from vibration. It may also cause jamming or breakage of drill bits.

8. (a) Thermal expansion is the increase in size or volume of a metal due to a rise in temperature. It must be considered when designing mechanical assemblies that experience heat.

(b) (i) Thermal expansion can loosen bolts and fasteners in heated environments. It causes distortion in metal structures. It may affect alignment of parts in precision assemblies.
(ii) Expansion joints are used to absorb length changes. Use of flexible couplings in shafts allows motion without damaging components.

(c) If thermal expansion is not managed, parts may warp or deform, leading to misalignment and mechanical failure. In press-fitted parts, expansion may cause loosening or cracking under stress.

(d) Components such as engine cylinder blocks, pipelines, rail tracks, and pressure vessels are designed with allowances or features to accommodate thermal expansion safely.