THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATION COUNCIL

DIPLOMA IN TECHNICAL EDUCATION EXAMINATION

789 METAL WORKING AND MECHANICAL PRACTICE

(SUPPLEMENTARY)

Time: 3 Hours. **ANSWER** **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) Define drilling and its importance in workshop operations.

Drilling is a machining process that involves making a round hole in a workpiece using a rotating cutting tool called a drill bit. It is one of the most common operations in workshops and is performed on drilling machines, lathes, or milling machines.

The importance of drilling lies in its ability to produce precise holes required for assembly, fastening, and machining operations. Drilling provides holes for bolts, rivets, screws, and shafts, making it essential in mechanical fabrication and manufacturing.

(b) Explain four types of drill bits and their applications.

The twist drill bit is the most common type, used for drilling holes in metals, wood, and plastics. It has helical grooves called flutes that help remove chips from the cutting zone.

The center drill bit is used for creating small starting holes, also called center holes, which guide larger drills or prepare workpieces for turning operations in lathes.

The flat drill bit is primarily used in woodworking. It has a flat cutting edge and is suitable for boring large, shallow holes.

The step drill bit is used for drilling holes of different diameters in thin materials such as sheet metal. It eliminates the need for multiple drill sizes by having stepped cutting edges.

(c) List two safety precautions when drilling metals.

Always secure the workpiece firmly with a vice or clamps before drilling to prevent it from spinning.

Wear safety goggles to protect your eyes from flying chips, and never use bare hands to remove chips from the drilling area.

2. (a) Explain hand filing in mechanical workshop practice.

Hand filing is a manual finishing process in which a file, a hardened steel tool with cutting teeth, is used to remove small amounts of material from a workpiece. It is commonly used to smooth rough edges, shape surfaces, and achieve close tolerances.

(b) Describe four points to ensure good results in filing.

The workpiece must be clamped securely in a vice to prevent movement during filing.

The file should be selected based on the type of work, such as roughing or finishing, and the material being worked on.

The filing stroke should be even and straight, covering the full length of the file to achieve a uniform finish.

The file should be kept clean by using a file card to remove chips that clog the teeth, which would otherwise affect surface quality.

(c) Explain three methods of filing:

i) Draw filing is performed by holding the file with both hands across the workpiece and moving it sideways. This method produces a very smooth surface finish and is mainly used for finishing.

ii) Push filing involves holding the file by the handle and pushing it forward along the surface of the workpiece. It is the most common method and is used for general filing tasks.

iii) Curved filing is done with specially curved files, applying the tool in a curved motion. It is suitable for filing contoured or irregular surfaces.

3. (a) Define sawing and its significance in metal cutting.
Sawing is the process of cutting a workpiece into desired lengths or shapes using a saw blade. In metalworking, it is used to cut bars, rods, pipes, and plates.

Its significance lies in its efficiency for separating materials before further machining. It provides an economical and quick method to prepare blanks for milling, turning, or welding.

(b) Differentiate between power hacksaw and hand hacksaw.
A power hacksaw uses a motor-driven blade that moves automatically in a reciprocating motion to cut metal stock. It is suitable for heavy-duty work and repetitive cutting tasks.

A hand hacksaw, on the other hand, is operated manually by the worker using a frame and blade. It is lightweight, portable, and used for smaller jobs or in places without machines.

(c) List two materials used for hacksaw blades and their advantages.

High-speed steel (HSS) is used for hacksaw blades because it retains hardness at high temperatures and resists wear.

Bimetal blades, which combine flexible steel backing with HSS teeth, are advantageous because they resist breakage and can cut tough materials.

4. (a) Explain the purpose of lubrication in machining.

Lubrication in machining reduces friction and heat between the cutting tool and the workpiece. It improves surface finish, reduces tool wear, and increases tool life.

(b) Describe four types of lubricants used in mechanical operations.

Cutting oils are mineral-based lubricants used in turning, milling, and drilling to reduce heat and wear.

Synthetic lubricants are chemically engineered oils that provide excellent thermal stability and are used in high-performance operations.

Solid lubricants, such as graphite and molybdenum disulfide, are used in conditions where liquid lubricants cannot function effectively.

Emulsions, also called soluble oils, are mixtures of oil and water used for cooling and lubrication in light machining operations.

(c) Discuss two methods of applying lubrication effectively.

The flood method involves applying a continuous stream of lubricant directly onto the cutting zone, ensuring maximum cooling and lubrication.

The mist method sprays a fine mist of lubricant mixed with compressed air onto the cutting area, reducing consumption while still providing cooling.

5. (a) Define welding and its importance in workshop practice.

Welding is a fabrication process that joins two or more pieces of metal by heating them to their melting point, with or without filler material.

Its importance lies in producing strong, permanent joints used in construction, automobile industries, shipbuilding, and machine fabrication.

(b) Explain two types of welding processes:

i) Shielded metal arc welding (SMAW) uses a consumable electrode coated with flux. The flux melts during welding to create shielding gas and slag, protecting the molten weld from contamination. It is widely used for structural steel work.

ii) Gas welding uses a mixture of oxygen and fuel gases such as acetylene to produce a flame hot enough to melt metals. It is commonly used for sheet metal fabrication, repair, and light construction.

(c) Outline three safety measures to prevent welding accidents.
Always wear proper personal protective equipment such as welding helmets, gloves, and aprons.

Ensure good ventilation or exhaust systems to prevent inhalation of harmful fumes.

Keep flammable materials away from the welding area to reduce the risk of fire accidents.

6. (a) Describe the function of a surface grinder.
A surface grinder is used to produce smooth, flat, and accurate surfaces by removing small amounts of material with a rotating abrasive wheel. It is commonly used for finishing hardened materials and tool-making.

(b) Explain four maintenance practices for grinding machines.
Regularly clean the machine and remove dust or swarf to prevent wear on moving parts.

Check and replace worn grinding wheels to maintain performance and safety.

Lubricate bearings and moving parts as recommended to ensure smooth operation.

Inspect and adjust wheel alignment and balancing to prevent vibrations and poor surface finishes.

(c) Draw a diagram of a grinding wheel and label four parts.
I cannot physically draw here, but a grinding wheel diagram should include the following labeled parts: abrasive grains, bond material, wheel structure, and the wheel hub or mounting hole.

7. (a) A workpiece of diameter 40 mm is to be milled with a 10 mm depth of cut. Calculate:

i) Material removal rate (MRR).

Given: Feed = 0.15 mm/tooth, Spindle speed = 1200 rev/min, Depth of cut = 10 mm, Workpiece diameter = 40 mm

MRR = Feed × Depth of cut × Speed × Width of cut

= 0.15 × 10 × 1200 × 40

= 72,000 mm^3/min

ii) Power required if cutting force is 600 N.

Cutting speed = π × Diameter × N ÷ 1000

= 3.142 × 40 × 1200 ÷ 1000

= 150.8 m/min = 2.51 m/s

Power = Force × Velocity = 600 × 2.51 = 1506 W ≈ 1.51 kW

(b) Determine the time required to mill a length of 200 mm.

Feed per minute = 0.15 × 1200 = 180 mm/min

Time = Length ÷ Feed per minute = 200 ÷ 180 = 1.11 min ≈ 67 seconds

(c) Calculate the cutting speed of the workpiece.

Cutting speed = π × D × N ÷ 1000

= 3.142 × 40 × 1200 ÷ 1000

= 150.8 m/min

8. (a) A lathe operation is to produce a 30 mm diameter hole by drilling and boring. Calculate:

i) Spindle speed for a drill of 25 mm diameter at cutting speed of 25 m/min.

N = (1000 × V) ÷ (π × D)

= (1000 × 25) ÷ (3.142 × 25)

= 1000 ÷ 3.142 ≈ 318 rev/min

ii) Torque required if the cutting force is 400 N at radius of 12.5 mm.

Torque = Force × Radius = 400 × 0.0125 = 5 Nm

(b) Determine the feed per revolution if the hole is drilled in 20 seconds over a depth of 40 mm.

Feed per revolution = Depth ÷ (N × Time)

= 40 ÷ (318 × 20)

= 40 ÷ 6360

≈ 0.0063 mm/rev

(c) Calculate the reaming allowance if the final hole is 30.2 mm and the drilled hole is 30 mm.

Reaming allowance = 30.2 – 30 = 0.2 mm