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: 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) **Define broaching and its applications.**
   Broaching is a machining process in which a toothed tool called a broach is pushed or pulled across a surface to remove material in a precise and continuous manner. It is used to produce accurate shapes, sizes, and finishes in a single pass.

   The applications of broaching include making keyways in gears, producing splines on shafts, machining holes with non-circular cross-sections, and finishing flat or contoured surfaces that require high precision.

   (b) **Explain the types of broaches with examples.**
   There are two main types of broaches, namely internal broaches and external broaches. Internal broaches are used to machine the inside surfaces of a hole. For example, they are used to cut keyways or splines inside gears or bushings.

   External broaches are used to cut the outside surfaces of a workpiece. An example is a surface broach, which is applied to machine flat or contoured surfaces on parts such as automotive components.

   (c) **List two advantages of broaching.**
   One advantage of broaching is that it allows complex shapes to be machined in a single pass, which saves time and ensures consistency in production.

   Another advantage is that broaching provides high accuracy and excellent surface finish, reducing or eliminating the need for further finishing operations.

2. (a) **Explain shaping and its applications.**
   Shaping is a machining process where a single-point cutting tool moves in a linear path over a workpiece to produce flat or contoured surfaces. The tool moves forward during the cutting stroke and retracts during the return stroke.

   Applications of shaping include producing flat surfaces, slots, grooves, and angular surfaces. It is also used for preparing surfaces that need further machining processes such as milling or grinding.

   (b) **Describe four safety measures when using a shaping machine.**
   The operator should always wear safety goggles to protect the eyes from metal chips during shaping.

The workpiece must be securely clamped to the machine table to prevent it from moving during the cutting operation.

Hands and clothing should be kept away from the moving tool and workpiece to avoid accidents.

The shaping machine must be switched off and allowed to stop completely before making adjustments to the tool or workpiece.

(c) **Outline three types of shaping operations.**
Horizontal shaping is performed when the tool moves in a horizontal direction, often for flat surfaces.

Vertical shaping involves tool movement in the vertical direction and is commonly used to machine keyways.

Angular shaping is used when the tool cuts inclined surfaces, which are often required in mechanical components.

3. (a) **Define planing and its importance in workshop practice.**
Planing is a machining process in which the workpiece is moved back and forth under a stationary single-point cutting tool to produce flat, long, and wide surfaces.

Its importance in workshop practice lies in the ability to machine large workpieces that cannot be easily handled on a shaper or milling machine, making it suitable for heavy-duty surface preparation.

(b) **Explain four advantages of planing over other cutting methods.**
Planing allows machining of very large workpieces, which may not be possible in shaping or milling.

It provides high accuracy in producing flat surfaces over long lengths, ensuring uniformity.

Planing is capable of handling heavy cuts, making it more efficient for large material removal.

It can machine multiple workpieces clamped together, which improves productivity in batch production.

(c) **Describe two types of planers and their applications.**
Open-side planers have only one housing or column, which allows machining of very wide workpieces. They are commonly used in shipbuilding and heavy machinery workshops.

Double-housing planers have two vertical housings that provide rigidity and stability, making them suitable for machining long and narrow components such as machine beds.

4. (a) **Explain brazing and its advantages.**
Brazing is a metal joining process in which two metal surfaces are bonded together using a filler metal with a lower melting point than the base metals. The filler metal is drawn into the joint by capillary action.

The advantages of brazing include the ability to join dissimilar metals, production of strong and leak-proof joints, and the fact that it does not melt the base metal, thus avoiding distortion.

(b) **List two types of brazing alloys with examples.**
Copper-based alloys, such as copper-zinc, are widely used for brazing steel and cast iron components.

Silver-based alloys, such as silver-copper, are used where high-strength and corrosion-resistant joints are required, for example in refrigeration equipment.

(c) **Outline two factors affecting the effectiveness of brazing.**
Proper surface preparation of the base metals, including cleaning and removing oxides, is necessary to ensure good bonding.

Correct heating temperature must be maintained to allow proper flow of the filler metal without overheating the base metal.

5. (a) **Explain filing and its purposes in workshop practice.**
Filing is a finishing process that involves removing small amounts of material from a workpiece using a hand tool called a file. It is performed to smooth, shape, or size a surface accurately.

The purposes of filing include removing burrs and sharp edges, producing flat or curved surfaces, and achieving precise dimensions on components after machining.

(b) **Describe three methods of filing.**
Draw filing involves holding the file at right angles to the workpiece and moving it back and forth. This method produces a smooth surface finish.

Push filing is the most common method where the file is pushed forward along the workpiece to cut material. It is used for general shaping and smoothing.

Curved filing is performed using files with curved surfaces to finish concave or convex workpieces, such as in automotive body repair.

(c) **List four points for achieving good filing results.**
The correct type and grade of file should be selected for the material being worked on.

The file should be held firmly with even pressure applied during each stroke.

Lubricants such as chalk can be used to prevent clogging of file teeth.

The file should be cleaned regularly with a file card to maintain cutting efficiency.

6. (a) **Describe the purpose of a power hacksaw.**
A power hacksaw is a machine used to cut metal bars, rods, and sections into required lengths by means of a reciprocating blade driven by a motor.

(b) **List four advantages of using a power hacksaw.**
It reduces manual labor compared to a hand hacksaw, making it less tiring for the operator.

It cuts faster and more consistently, improving productivity.

It allows cutting of thicker and harder materials with ease.

It provides better accuracy and straighter cuts than manual cutting.

(c) **Identify two materials used for making hacksaw blades.**
High carbon steel is used for general-purpose cutting because it is strong and inexpensive.

High-speed steel is used for cutting harder materials since it retains hardness even at high temperatures.

7. (a) A 120 mm × 50 mm × 30 mm workpiece is to be milled.

(i) **Material removal rate**

MRR = feed per tooth × number of teeth × spindle speed × depth of cut × width of cut.

Assume a 4-tooth cutter.

MRR = 0.2 × 4 × 900 × 3 × 50 mm^3/min

MRR = 108,000 mm^3/min = 108 cm^3/min

(ii) **Power required**

Power = (Cutting force × Cutting speed) / 60,000

Cutting speed = πDN/1000 = (3.142 × 120 × 900)/1000 = 339 m/min

Power = (700 × 339)/60,000 = 3.96 kW

(b) **Time required to remove a length of 100 mm**

Feed rate = feed per tooth × number of teeth × spindle speed

Feed rate = 0.2 × 4 × 900 = 720 mm/min

Time = length / feed rate = 100 / 720 = 0.14 min = 8.3 sec

(c) **Calculate cutting speed**

Cutting speed = πDN/1000 = (3.142 × 120 × 900)/1000 = 339 m/min

8. (a) A hole of 25 mm diameter is drilled and reamed in a steel plate of 20 mm thickness.

(i) **Reaming allowance**

Reaming allowance = Final hole diameter − Drilled hole diameter

= 25.2 − 25 = 0.2 mm

(ii) **Spindle speed**

Cutting speed V = πDN/1000

30 = (3.142 × 25 × N)/1000

N = (30 × 1000) / (3.142 × 25) = 382 rev/min

(b) **Feed per revolution if hole is drilled in 15 seconds**

Length drilled = 20 mm

Drilling speed = 382 rev/min = 6.37 rev/s

Total revolutions in 15 s = 6.37 × 15 = 95.5 rev

Feed per rev = 20/95.5 = 0.21 mm/rev

(c) **Torque**

Torque = Force × Radius

= 400 × 0.0125 m

= 5 N·m