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: 2000**

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) Give the meaning of the term 'fitting' as used in mechanical workshop activities.

Fitting refers to the process of assembling, adjusting, and finishing metal components by the use of hand tools such as files, chisels, scrapers, hammers, and measuring instruments to ensure accurate shape, size, and smooth surface finish. It mainly involves manual operations carried out at the bench to make sure that parts fit together properly in an assembly. The purpose of fitting is to achieve accuracy where machine work alone cannot produce the required precision.

1. (b) (i) Write four points to signify the proper use of a bench vice.

The bench vice should always be securely fastened to the workbench to avoid vibrations or movement when holding workpieces. This ensures safety and stability while filing, sawing, or hammering.

The jaws of the vice should be kept clean and free from oil, dirt, or chips so that the grip on the workpiece remains firm. This prevents slipping that may cause inaccuracies or accidents.

Soft jaw covers made from copper, aluminium, or lead should be used when clamping softer materials such as brass or aluminium. This prevents damage to the workpiece surface from the serrated steel jaws.

The handle of the bench vice should not be hammered or extended with a pipe to increase clamping force. Excessive force can damage the threads of the screw or the body of the vice, reducing its lifespan.

1. (b) (ii) State two precautions that should be observed to protect the vice from damage.

The jaws of the vice should not be used as an anvil for hammering operations. Hammering on the vice can crack its body or misalign its jaws.

The vice should never be overtightened beyond what is necessary to hold the workpiece. Over-tightening causes wear on the screw and nut mechanism, leading to permanent damage.

1. (c) Describe the process of 'draw filing' and state its main purpose.

Draw filing is a method of filing where the file is held at right angles to the workpiece surface and drawn backward and forward across it using both hands. Unlike ordinary filing which is performed along the length of the work, draw filing smoothens the surface by removing very fine layers of material.

The main purpose of draw filing is to obtain a smooth, polished, and flat surface finish on the workpiece after the initial filing process. It is especially useful when preparing a surface for finishing operations such as polishing or painting.

2. (a) (i) Define the term 'layout fluid' or 'marking medium'.

A layout fluid or marking medium is a thin, colored coating applied on the surface of a metal workpiece before marking out. It creates a contrasting background that makes the scribed lines or marks highly visible during layout work.

2. (a) (ii) Give three examples of materials commonly used as layout fluid in the workshop.

Prussian blue is commonly used because it spreads thinly and provides a dark background that makes fine lines stand out clearly.

Copper sulphate solution mixed with water is used especially on steel surfaces because it creates a thin copper coating that is easily marked with a scriber.

Commercially available dye-based marking fluids are also widely used. They dry quickly and provide a durable colored surface for accurate marking.

2. (b) Describe the use of 'parallel blocks' in the setup of a workpiece on a machine table.

Parallel blocks are hardened steel rectangular blocks of precise and equal thickness. They are placed beneath the workpiece to elevate it to the required height on the machine table.

They also ensure that the workpiece is supported evenly and parallel to the table surface, which is crucial for accurate machining operations such as drilling, milling, or grinding.

Parallel blocks allow clearance for the cutting tool to pass through the workpiece without damaging the machine table surface.

2. (c) Explain the purpose of 'oil grooves' or 'oil ways' in plain bearings.

Oil grooves or oil ways are shallow channels cut into the surface of plain bearings. Their main purpose is to distribute lubricating oil evenly over the bearing surface.

They also act as reservoirs to hold oil so that continuous lubrication is maintained, reducing friction between the bearing and the shaft.

By ensuring proper lubrication, oil grooves reduce wear and overheating of the bearing, thereby increasing its service life and the efficiency of the machine.

3. (a) Outline the steps required to properly read the measurement from a vernier caliper.

First, close the jaws of the vernier caliper and check for zero error to ensure accuracy. If there is a discrepancy, it should be noted and corrected during the reading.

Next, open the jaws and place them around the workpiece to be measured, ensuring firm but not excessive pressure to avoid errors.

Read the main scale measurement just before the zero mark of the vernier scale. This gives the whole millimeters or centimeters of the measurement.

Finally, read the vernier scale to find which division coincides with a division on the main scale. Add this reading to the main scale reading to obtain the final measurement.

3. (b) Explain the difference between accuracy and precision in metrology, giving a relevant example in machining.

Accuracy refers to how close a measurement is to the true or actual value. For example, if a shaft is supposed to be 20.00 mm in diameter and the measurement taken is 20.01 mm, it is considered accurate because it is close to the intended dimension.

Precision, on the other hand, refers to the ability to take repeated measurements that are consistent with each other, regardless of whether they are close to the true value. For instance, if repeated measurements of the same shaft give 19.80 mm consistently, the results are precise but not accurate.

In machining, both accuracy and precision are required. A dimension must be accurate to meet design requirements and precise to ensure consistency across multiple parts.

3. (c) Describe the proper method of cleaning and storing precision measuring instruments like a micrometer.

After use, the micrometer should be wiped clean with a soft cloth to remove oil, dust, or metal particles. Care must be taken not to scratch the measuring surfaces.

The spindle should be slightly opened before storage to avoid continuous pressure on the measuring faces, which could lead to distortion.

A thin film of rust-preventive oil should be applied on the surfaces to protect against corrosion.

Finally, the micrometer should be stored in its protective case in a dry place, away from heat and humidity, to prolong its accuracy and service life.

4. (a) Briefly explain three points to ensure the correct setting of the cutting edge of a hacksaw blade on the frame.

The teeth of the blade should face forward, away from the handle, because the cutting action occurs on the forward stroke.

The blade must be tightened firmly in the frame so that it does not bend or twist during sawing. A loose blade will wander and produce inaccurate cuts.

The blade should be aligned straight with the frame to prevent uneven cutting and reduce the risk of breakage. Misalignment causes binding and increases wear on the blade.

4. (b) (i) Differentiate between the 'fixed jaw' and the 'sliding jaw' of a bench vice.

The fixed jaw is permanently attached to the body of the vice and remains stationary when clamping a workpiece. It provides a stable reference surface.

The sliding jaw moves along the guide as the handle is turned, bringing it towards or away from the fixed jaw to hold the workpiece securely in place.

4. (b) (ii) State three reasons why a properly sharpened file must not be stored in a drawer with other tools.

When files are stored with other tools, the sharp teeth can rub against hard surfaces, causing them to dull quickly.

The teeth may also get clogged or damaged when in contact with oily or dirty tools, reducing the efficiency of filing.

Additionally, files can scratch or damage other tools in the drawer because of their sharp cutting edges, leading to avoidable tool wear.

4. (c) What are the two main purposes of the tang on a hand file?

The tang allows the file handle to be securely fitted, providing a safe grip for the user. Without a handle, the tang can cause injuries when force is applied.

It also serves to transmit the filing force from the user's hand through the handle to the file body, ensuring effective cutting action.

5. (a) Describe the following features in connection with files: (i) Size of the file (ii) Cut of the teeth (iii) Grade of cut of the file (iv) Shape of the file

The size of the file refers to its overall length, usually measured from the tip of the point to the heel, excluding the tang. Sizes vary depending on the type of work to be performed.

The cut of the teeth refers to the pattern in which the teeth are arranged. Files can be single cut, with parallel rows of teeth, or double cut, with intersecting rows of teeth.

The grade of cut indicates the coarseness or fineness of the teeth. Rough cut files remove material quickly but leave a coarse finish, while smooth cut files remove less material but give a fine finish.

The shape of the file refers to its cross-sectional form, such as flat, round, half-round, triangular, or square. Each shape is suited to different filing applications.

5. (b) Explain the term 'chipping' and how the process is carried out using a cold chisel.

Chipping is the process of cutting away unwanted material from a workpiece using a cold chisel and hammer. It is mainly used for rough shaping or removing metal in areas not accessible by machines.

The cold chisel is positioned at a suitable angle on the workpiece surface, and a hammer is used to strike its head. This shears off chips of material through a wedging action.

The operation is continued until the required shape or surface is obtained, after which the surface may be finished by filing.

5. (c) Describe the use of a surface plate in marking out and inspection.

A surface plate provides a flat, stable reference surface for accurate marking out of workpieces. Scribed lines can be drawn with the help of a surface gauge placed on the plate.

It is also used as a standard reference for checking the flatness, squareness, or parallelism of components during inspection.

By providing a smooth and precise base, the surface plate improves the accuracy and reliability of both layout and measurement work.

6. (a) Explain the function of each of the following in marking out: (i) The angle plate (ii) Vee blocks (iii) The surface gauge (iv) The engineer's hammer

The angle plate is used to hold workpieces at a right angle to the surface plate, enabling accurate marking of vertical or perpendicular lines.

Vee blocks are used to support cylindrical workpieces during marking or machining. They hold the round bar firmly so that accurate lines can be marked along its axis.

The surface gauge is used with a scriber to mark lines on the workpiece parallel to the surface plate or at a specific height.

The engineer’s hammer is used to lightly tap marking tools such as center punches to create indentations that serve as drilling guides.

6. (b) Outline the general procedures of marking out a workpiece.

The workpiece should first be cleaned to remove dirt, rust, or oil so that marks are clear and accurate.

A thin layer of marking medium, such as layout dye or chalk, should be applied to the surface to improve visibility of scribed lines.

Reference lines or centerlines are drawn first, using accurate instruments like a steel rule, dividers, or surface gauge.

All required dimensions are carefully transferred from the drawing to the workpiece, ensuring accuracy at every step.

Finally, critical points such as hole positions are marked with a center punch to guide drilling.

6. (c) Outline the requirements for laying out lines using a surface gauge or a vernier height gauge.

The surface plate must be clean and free from dust to provide a stable reference.

The gauge must be adjusted carefully to the required height using its fine adjustment screws.

The scriber should be sharp and properly aligned to ensure clear and accurate lines.

The workpiece must be firmly clamped or supported so it does not shift during marking.

7. (a) Write four factors that should be considered when selecting a specific type of wrench for a task.

The size of the nut or bolt should match the wrench opening to ensure a good grip and avoid rounding off the fastener.

The amount of torque required should be considered, as some wrenches, such as socket wrenches, allow greater torque application than spanners.

The accessibility of the fastener is important; for tight spaces, an adjustable wrench or ring spanner may be more suitable.

The material and strength of the fastener should also be considered to avoid tool slippage or breakage.

7. (b) Explain the importance of 'tinning' a soldering iron tip.

Tinning is the process of coating the soldering iron tip with a thin layer of solder. It ensures better heat transfer from the tip to the workpiece, making soldering more efficient.

It also prevents oxidation of the tip, which would otherwise reduce its ability to hold solder and conduct heat.

Additionally, tinning extends the lifespan of the soldering iron tip by protecting it from wear and corrosion.

7. (c) Differentiate between 'punching' and 'piercing' in sheet metal work.

Punching is the process of removing a slug of material from a sheet by pressing a punch through it, leaving a hole in the sheet. The hole is the useful feature in this case.

Piercing, on the other hand, is the process of creating an opening in a sheet where the removed slug is the useful part, and the hole is considered scrap.

8. (a) Calculate the taper per foot (TPF) for a workpiece that has a large diameter of 50 mm, a small diameter of 40 mm, and a tapered length of 150 mm.

TPF = (D - d) / L × 12

= (50 - 40) / 150 × 12

= 10 / 150 × 12

= 0.0667 × 12

= 0.8 mm per foot.

8. (b) If the total length of thread to be cut is 5 inches and the thread has 8 threads per inch (T.P.I.), calculate the total number of complete threads.

Total threads = Length × TPI

= 5 × 8

= 40 complete threads.

8. (c) Calculate the allowable working stress for a component if the Ultimate Tensile Strength (UTS) of the material is 700 MPa and a safety factor of 4 is to be used.

Allowable stress = UTS / Factor of safety

= 700 / 4

= 175 MPa.