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: 2002**

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) Hand tools refer to tools that are powered solely by human effort without the use of electricity or other external power sources. In a mechanical workshop, these tools are commonly used for tasks such as cutting, shaping, measuring, and assembling metal components during fitting and fabrication processes.

   (b) The file is a hand tool used to smooth or shape metal surfaces by removing small amounts of material. It comes in different shapes and cuts, depending on the work requirement. The hammer is used for striking operations, such as fitting components or driving nails and chisels. It comes in types like ball peen, cross peen, and soft face hammers. The hacksaw is used for cutting metal rods or bars. It consists of a frame that holds a replaceable blade with fine teeth. The spanner is a tool used for tightening or loosening bolts and nuts. It comes in different types such as adjustable, ring, or open-ended spanners, each designed for specific applications.

   (c) Hand tools should be cleaned regularly to remove grease, dirt, or metal shavings that could cause corrosion or wear. Tools with sharp edges, like files and chisels, should be stored in dry places to prevent rusting. Handles should be checked and replaced if loose or damaged to avoid injury. Tools should always be returned to their proper storage area after use to prevent loss or misuse.

   (d) Improper use of hand tools can cause injuries such as cuts, bruises, or even fractures due to slipping or using the wrong tool for the job. Damaged tools may break during operation, posing a serious hazard. Tools left on benches or floors can cause tripping accidents. Excessive force applied to hand tools may lead to strained muscles or repetitive strain injuries.

2. (a) Metal sawing using a hand hacksaw involves securing the workpiece in a vice, fitting the appropriate blade in the hacksaw frame with the teeth pointing away from the handle, and using forward strokes to cut through the material. The process requires steady pressure and proper alignment to ensure a clean and accurate cut.

   (b) Blade breakage during sawing may be caused by applying too much pressure, which stresses the teeth and causes cracks. Misalignment of the blade in the frame can lead to uneven loading and eventual snapping. Using a worn or dull blade increases friction and leads to breakage. Starting the cut abruptly without guiding the blade can also damage the teeth. To prevent these issues, use moderate pressure, align the blade properly, replace worn blades, and start cuts with light guiding strokes.

   (c) A junior hacksaw is smaller and lighter than a standard hand hacksaw. It is used for light-duty tasks, especially where access is limited. The blade of a junior hacksaw is thinner and shorter, and the frame is usually made of lightweight material, making it easier to control for small or delicate cuts.

   (d) When using a hand hacksaw, ensure the blade is tight and correctly fitted with the teeth facing forward. Keep hands away from the blade's path to avoid injury. Saw with even and controlled strokes, applying pressure on the forward stroke and easing on the return. Always wear safety goggles to protect your eyes from flying metal particles.

3. (a) Forging is a metalworking process in which metal is shaped by applying compressive forces using tools such as hammers, presses, or dies. The purpose of forging is to produce components with superior strength, improved grain structure, and better mechanical properties by deforming the metal while it is hot or cold.

   (b) The anvil provides a solid surface on which the metal is placed and shaped during forging. It contains flat and curved surfaces suitable for various shaping tasks. The swage block is a large block of cast iron with various holes and shapes used for forming curves or angles in metal. The fuller is a forging tool used to spread the metal and create grooves. Tongs are used to grip and hold hot metal pieces securely during the forging process, keeping the operator safe.

   (c) To forge a round bar into a flat shape, the bar is first heated to a suitable forging temperature. Once heated, it is placed on the anvil and struck with a hammer to begin flattening. The bar is rotated periodically to ensure even flattening on all sides. The process continues until the desired flat shape and thickness are achieved, and the piece is then cooled gradually.

   (d) Forging has advantages over casting such as producing components with greater strength and toughness due to grain refinement. It results in fewer internal defects such as porosity or shrinkage. Forged components have better wear resistance and fatigue strength, making them ideal for high-stress applications.

4. (a) Gas welding is a process of joining metals by heating them with a flame produced by burning a fuel gas, usually acetylene, with oxygen. The heat melts the base metal and a filler rod is used to fill the joint, forming a strong bond when cooled. Two common gases used in gas welding are oxygen and acetylene.

   (b) The regulator controls the pressure of gases released from the cylinders to ensure a stable and safe flow to the torch. The hose is the flexible tubing that transports the gases from the cylinders to the torch. The nozzle, attached to the torch, controls the shape and direction of the flame. The cylinder is the storage container for the compressed gas, either oxygen or acetylene.

   (c) A neutral flame has equal amounts of oxygen and acetylene and produces a clear, non-oxidizing flame suitable for general welding. An oxidizing flame has excess oxygen, burns hotter, and is used for welding metals like brass. Neutral flame has a short, sharply defined inner cone, while an oxidizing flame has a shorter and bluer inner cone. The neutral flame does not affect the chemistry of the metal, while the oxidizing flame can cause oxidation or burn the material.

   (d) Safety precautions include checking all hoses and connections for leaks before use. Avoid oil or grease near oxygen equipment as they may cause explosions. Always wear protective goggles, gloves, and a flame-resistant apron. Ensure good ventilation in the welding area to prevent the buildup of harmful gases.

5. (a) A vernier caliper is a precision measuring instrument used to measure internal and external dimensions as well as depths with high accuracy. It is commonly used in workshops to check the diameter of rods, pipes, and holes.

(b) To measure a cylindrical object, the vernier caliper jaws are first cleaned. The object is placed between the fixed and sliding jaws. The jaws are then gently closed to make firm contact with the object without squeezing. The measurement is read from where the vernier scale aligns with the main scale.

(c) Limitations of the vernier caliper include the difficulty of reading small graduations without proper lighting. It may not measure very large dimensions compared to other instruments like micrometers or height gauges. Dirt or burrs on the workpiece can cause inaccurate readings if not cleaned properly.

(d) To avoid parallax error, the user must ensure their eye is directly in line with the scale reading. Viewing from an angle can result in incorrect readings. Using vernier calipers with a magnifier or digital display can also help minimize this error.

6. (a) Reaming is the process of enlarging and finishing a drilled hole to an exact diameter with a smooth surface. It is used to produce holes with tight tolerances that cannot be achieved by drilling alone.

   (b) Hand reamers are operated manually and have a square end for use with a tap wrench. Machine reamers are designed for use in drilling machines or lathes and usually have a straight or tapered shank for mounting. Hand reamers are suitable for maintenance work, while machine reamers are used in high-volume production.

   (c) Internal reaming involves securing the workpiece and applying cutting fluid to the hole. The reamer is then inserted into the hole, aligned properly, and rotated slowly in a clockwise direction while applying gentle pressure. It is important not to reverse the reamer while inside the hole to prevent damage.

   (d) Accuracy of a reamed hole depends on the quality of the reamer, the alignment of the tool with the hole, the type of material being reamed, and the consistency of the cutting speed and feed. Using dull tools or incorrect speeds can lead to oversized or rough holes.

7. (a) Filing allowance is the extra material intentionally left on a workpiece during rough cutting or sawing to be removed later by filing to achieve the final dimensions. It ensures that any surface irregularities or errors can be corrected.

   (b) Using an incorrect filing allowance can result in a component that is either too large or too small. Excess allowance increases filing time and effort, while insufficient allowance leaves no room for error correction, potentially wasting material.

   (c) Draw filing is a technique where the file is held with both hands and drawn lengthwise along the surface of the workpiece. This method produces a fine and smooth finish and is commonly used in finishing flat surfaces.

(d) Files wear out prematurely due to using them on inappropriate materials like hardened steel. Applying excessive pressure during filing can damage the teeth. Lack of proper cleaning after use allows metal shavings to clog the teeth. Using the file as a pry tool or for hammering also leads to early failure.

8. (a) Workpieces can be held using a bench vice, which clamps the object firmly for filing or sawing. C-clamps are used to secure parts temporarily on tables. V-blocks hold cylindrical workpieces during drilling. Angle plates provide support for marking or drilling at specific angles.

(b) Securing the workpiece ensures that it does not move during operation, which prevents injury and improves accuracy. It allows for even pressure application during cutting or filing. Proper holding prevents damage to both the tool and the workpiece.

(c) A bench vice should be regularly cleaned and lubricated to ensure smooth operation. The jaws should be checked for wear and replaced if damaged. The spindle and screw mechanism should be kept free from dirt and grit to avoid jamming.

(d) Using damaged workholding devices may lead to slipping, which can cause injury or result in inaccurate work. Worn-out jaws may not grip the workpiece firmly, leading to vibration and poor-quality finishes.