THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

092 **WORKSHOP TECHNOLOGY**

(For Both School and Private Candidates)

Time : 3 Hours **ANSWERS** **Year : 2019**

Instructions

1. This paper consists of sections A, B and C.
2. Answer all questions in section A and B and **three (3)** question from section C.
3. Non-programmable calculators may be used.
4. Communication devices and any unauthorised materials are **not** allowed in the examination room.
5. Write your **Examination Number** on every page of your answer booklet(s).

1. (i) A machinist in a workshop observes that the temperature of the metal rises when machining it. What is the cause of heat generation?

   A. Plastic deformation

   B. Elastic deformation

   C. Isotropic deformation

   D. Twinning

   E. Refining of grains

Correct answer: A. Plastic deformation

Reason: Heat is generated due to plastic deformation of the metal at the shear zone during machining.

(ii) You are required to select a metal for particular work. Which characteristics would you consider in identifying mild steel from other ferrous metals?

A. Red and scaly surface with rolling marks

B. Grey and sand surface

C. Fine and smooth surface with bluish sheen

D. Smooth and dark surface

E. Smooth and fine surface

Correct answer: A. Red and scaly surface with rolling marks

Reason: Mild steel often shows a red and scaly appearance with rolling marks after processing.

(iii) The following table shows pairs of materials and their respective products:

S/N	Material	Products
1	Silicon steel	Transformer stampings
2	Duralumin	Cooking utensils
3	Gun metal	Bearings

S/N	Material	Products
4	Bronze	Swords

Which one represents the correct matched pair of material and product?

A. 1, 2 and 3

B. 1 and 2

C. 1 and 3

D. 2 and 3

E. 3 and 4

Correct answer: C. 1 and 3

Reason: Silicon steel is used for transformer stampings and gun metal is used for bearings.

(iv) Which pair of heat treatment processes can be used to make steel strong and tough?

A. Tempering and annealing

B. Annealing and normalising

C. Normalising and tempering

D. Hardening and tempering

E. Anodizing and carburising

Correct answer: D. Hardening and tempering

Reason: Hardening increases strength and tempering improves toughness.

(v) Which process is suitable to produce steel materials for use in structural construction works?

A. Casting

B. Extrusion

C. Rolling

D. Forging

E. Deep drawing

Correct answer: C. Rolling

Reason: Rolling produces structural steel sections like beams, rails, and plates used in construction.

(vi) In which condition do carbon and iron exist when steel is heated to eutectic state?

A. Insoluble in solid and liquid state

B. Soluble in liquid state

C. Soluble in solid state

D. Insoluble in liquid state

E. Soluble in solid and liquid states

Correct answer: E. Soluble in solid and liquid states

Reason: At eutectic state, carbon and iron coexist in both solid and liquid phases.

(vii) Which one is a necessary condition for plastic moulding?

A. Application of heat only

B. Application of pressure only

C. Application of heat and pressure

D. Application of plasticizers only

E. Application of pressure and plasticizers

Correct answer: C. Application of heat and pressure

Reason: Plastic moulding requires both heat (to soften the plastic) and pressure (to shape it).

(viii) One of the properties of copper and aluminium is their good conductivity of electricity but aluminium is preferably used in overhead electricity transmission lines. Why is it so?

A. It is in weight and better in electric conductivity than copper.

B. It is better in corrosion resistance and electric conductivity.

C. It is less in weight and cheaper than copper.

D. It is better in corrosion resistance and less in weight than copper.

E. It is less in weight and better in electric conductivity than copper.

Correct answer: C. It is less in weight and cheaper than copper.

Reason: Aluminium is lighter and cheaper, making it suitable for overhead lines despite lower conductivity.

(ix) Which one of the following are the limits of size for the component which is manufactured with the dimensions 30.0 ± 0.05 mm?

A. 30.00 mm, -0.05 mm and +0.05 mm

B. 29.95 mm - 0.05 mm and +0.05 mm

C. 29 mm and 31 mm

D. 29.95 mm and 30.05 mm

E. 30 mm and 30.05 mm

Correct answer: D. 29.95 mm and 30.05 mm

Reason: With tolerance ±0.05, the limits of size are 29.95 mm and 30.05 mm.

(x) Which one is the best cutting solution for drilling mild steel?

A. Lard oil

B. Paraffin

C. Soluble oil

D. Turpentine

E. Natural oil

Correct answer: C. Soluble oil

Reason: Soluble oil provides lubrication and cooling during drilling of mild steel.

2. (a) State the required property for a material to be used for casting parts with intricate shapes.

The required property is high fluidity, which allows the molten metal to flow easily into complex moulds.

(b) Give three materials which have desirable properties for casting intricate shaped components.

The three materials are aluminium, cast iron, and brass.

3. (a) Give one lubricant in solid state.

Graphite is a lubricant in solid state.

(b) Give four types of lubricant in liquid state.

Four lubricants in liquid state are mineral oils, synthetic oils, vegetable oils, and animal oils.

4. Give five reasons of employing heat treatment to steel.

Heat treatment improves the hardness of steel.
It increases toughness and ductility.
It relieves internal stresses caused by machining or welding.
It refines the grain structure, improving mechanical properties.
It improves machinability and wear resistance.

5. (a) Identify the type of cast iron which is easily machined.

Grey cast iron is easily machined.

(b) Give the purpose of chilled castings as it is applied in cast iron production.

Chilled castings are used to produce a very hard surface layer on cast iron, which increases wear resistance.

(c) Identify two components in which cast iron is used as engine construction material.

Cast iron is used in engine blocks and cylinder heads.

6. Identify the types of metals which correspond to the following types of sparks:

(a) Sparks in long, light yellow streaks with a little tendency to burst.
This corresponds to wrought iron.

(b) Similar sparks as material in test (a) but has more sparks which burst with sparkler effect.
This corresponds to mild steel.

(c) Numerous little yellow stars burst very close to the grinding wheel.
This corresponds to high carbon steel.

(d) Interrupted spark lines with a dark red, ball shaped spark at the end.
This corresponds to alloy steel.

(e) Definite torpedo shaped spark with a feather-like effect near the end. It changes from a dark red to gold colour.
This corresponds to cast iron.

7. (a) Outline the benefits of using limits, fits and tolerances in manufacturing of mechanical components.

They ensure interchangeability of parts during assembly.
They improve accuracy and standardization in production.
They reduce manufacturing costs by avoiding unnecessary precision.
They guarantee proper functioning of assembled parts.
They save time in inspection and quality control.

(b) Give three methods in which parts made with interference fit can be assembled.

Shrink fitting by heating the outer part to expand.
Cooling fitting by cooling the inner part (e.g. liquid nitrogen).
Press fitting using hydraulic or mechanical presses.

8. Give five reasons for non-ferrous metals to have wide application in our daily activities.

Non-ferrous metals are resistant to corrosion, making them suitable for outdoor use.
They are good conductors of electricity and heat, suitable for wires and cookware.
They are lighter than ferrous metals, making them ideal for transport applications.
They are malleable and ductile, easy to shape into various forms.
They have attractive appearance, suitable for decorative purposes.

9. (a) Differentiate induction hardening from flame hardening.

Induction hardening uses electromagnetic induction to heat the surface before quenching. Flame hardening uses a high-temperature flame to heat the surface before quenching.

(b) Give two factors on which the depth of hardness for case hardened part depend.

The depth depends on the heating time.
It also depends on the temperature of heating.

10. (a) Outline three properties of aluminium material which make it more popular.

Aluminium is lightweight.
It is resistant to corrosion.
It has high electrical and thermal conductivity.

(b) Identify four common forms in which aluminium material is supplied during its manufacturing.

Aluminium is supplied in sheets, rods, wires, and extrusions.

11. (a) Describe the type of test that can be used to verify the suitability of steel in hand as a construction material for a structural work which will be subjected to shock loads.

The Charpy impact test can be used. It measures the toughness of steel by determining the amount of energy absorbed by a notched specimen when struck by a swinging pendulum hammer.

(b) Explain the Brinell Testing procedure for steel.

In the Brinell hardness test, a hardened steel or tungsten carbide ball indenter is pressed into the surface of the steel specimen using a specified load. After a fixed time, the load is removed and the diameter of the indentation is measured. The Brinell Hardness Number (BHN) is calculated from the load applied divided by the curved surface area of the indentation.

(c) Produce a shaft that can be able to fit on a plain bronze bushing of 35.05mm diameter. If the clearance required between shaft and bush is 0.05 mm, with the aid of drawing indicate limits and tolerances of the fit.

The bush diameter is 35.05 mm. Required clearance is 0.05 mm.
Therefore, shaft maximum diameter = 35.05 – 0.05 = 35.00 mm.
The limits of the shaft should be: 34.95 mm (minimum) and 35.00 mm (maximum).

(d) State the allowance obtained in 11(c).

The allowance is 0.05 mm, which is the minimum clearance between the shaft and the bush.

(e) Briefly explain three types of limit gauges used in checking components.

Plug gauges are used to check the internal dimensions of holes.
Snap gauges are used to check external dimensions such as shafts.
Ring gauges are used to measure the external diameter of cylindrical parts.

12. (a) Explain the composition and characteristics of the iron in the regions marked as A, B, C, D and E of the iron carbon thermal equilibrium diagram.

Region A: Ferrite, which is soft, ductile, and magnetic, containing very little carbon.
Region B: Austenite, which is a solid solution of carbon in gamma iron, non-magnetic and tough.
Region C: Cementite, which is iron carbide (Fe_3C), hard and brittle.
Region D: Pearlite, a mixture of ferrite and cementite with good strength and toughness.
Region E: Ledeburite, a eutectic mixture of austenite and cementite, hard and brittle.

(b) State two factors which tend to cause warping and cracking of metals during quenching.

Uneven cooling rates in different sections of the material.
Excessive cooling speed which causes thermal stresses.

(c) Give three reasons as to why some hot rolled steel need to be cold rolled.

Cold rolling increases surface finish and dimensional accuracy.
It improves mechanical properties such as hardness and tensile strength.
It reduces thickness and provides better control of size tolerances.

13. (a) Compare cold working from hot working processes by giving five points.

Cold working is done below recrystallization temperature while hot working is done above it.
Cold working increases strength and hardness, while hot working improves ductility.
Cold working gives a smooth surface finish, hot working gives a rough finish.
Cold working requires higher forces compared to hot working.
Hot working removes porosity and refines grains, cold working may cause internal stresses.

(b) Suggest the suitable material for making each of the following components:

(i) Base plate of a pillar drilling machine – Cast iron, because of its high compressive strength and vibration damping.
(ii) Blade of a power hacksaw – High speed steel, because it retains hardness at high temperature.
(iii) Crane hooks and chains – Wrought iron or alloy steel, because of toughness and resistance to shock loads.

(c) Give reasons of their choice of material in 13(b) for any two parts.

For the base plate, cast iron is chosen because it is cheap, easy to cast into shape, and absorbs vibrations.
For hacksaw blades, high speed steel is chosen because it maintains sharpness and cutting ability even at high temperatures.

14. (a) Compare end working from hot bulging hot working processes by giving five points.

End working involves deformation applied at the ends of the workpiece, while hot bulging involves deformation in the middle.
End working produces elongation, hot bulging produces expansion in diameter.
End working requires axial compressive forces, hot bulging requires internal pressure or external dies.
End working can be used for upsetting operations, hot bulging for producing hollow shapes.
Hot bulging requires high temperatures, end working can sometimes be done cold.

(b) State two factors which tend to cause warping and cracking of metals during quenching.

Uneven cooling of thick and thin sections.
Use of very severe quenching medium such as brine.

(c) Give five reasons for non-ferrous metals to have wide application in our daily activities.

They are resistant to corrosion.
They have good electrical and thermal conductivity.
They are lightweight compared to ferrous metals.
They are ductile and malleable, easy to form.
They have attractive appearance, useful in decoration and design.