Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2026

ENGINEERING – MATERIALS AND TECHNOLOGY

(Higher level – 300 marks)

THURSDAY, 4 JUNE **MORNING 9:30 – 12:30**

INSTRUCTIONS

1. Answer **any SIX** questions.

2. All questions carry equal marks.

3. All answers must be written in ink on the answer book supplied.

4. Diagrams should be drawn in pencil.

5. Squared paper is supplied for graphs, as required.

6. Please label and number carefully each question attempted.

Question 1. **(50 marks)**

Give **brief answers** to **any ten** of the following:

(a) State **two** advantages of using Quick Response (QR) codes in engineering applications.

(b) Identify **two** safety features integrated into a CNC lathe.

(c) Describe, with the aid of a diagram(s), the process of magnetic separation.

(d) Outline **one** mechanism that could be used to tilt the lifting platform shown.

(e) Differentiate, with the aid of a diagram(s), between a *clearance fit* and an *interference fit*.

(f) The *Dyson Airblade Wash+Dry* hand dryer, shown opposite, is an innovative appliance. Outline **two** attributes of this design.

(g) Identify a suitable material for the manufacture of the *Wash+Dry* appliance shown. Justify your selection.

(h) Discuss the contribution that **any one** of the following has made to technology:

(i) Nikola Tesla **(ii)** Eileen Gray **(iii)** Frank Whittle.

lounge chair

(i) Used tyres have been upcycled to create the lounge chair shown. Outline **two** benefits of *upcycling*.

(j) Describe **two** ways in which steel may be protected from corrosion.

(k) Explain briefly why metals with a face centred cubic (FCC) structure tend to be more ductile than metals with a body centred cubic (BCC) structure.

autonomous taxi

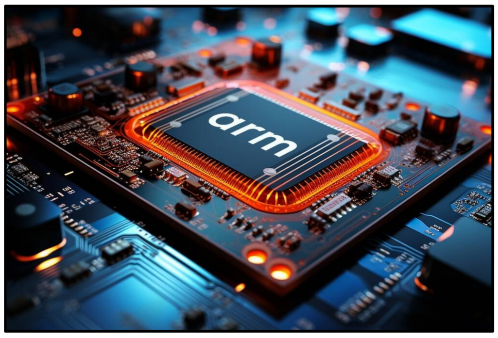
(l) How do Global Positioning System (GPS) technologies support the efficient and safe operation of autonomous taxis?

(m) State **two** benefits of using electric powered vehicles in urban areas.

Question 2. **(50 marks)**

Answer **all** of the following:

(a) Arm Holdings plc has provided primary architecture for mobile phone chips since the advent of the modern smartphone. This company plays a key role in phone semiconductor technology.



Describe **three** smartphone functions that depend on semiconductor technology.

(b) Semiconductor chips are essential components in an array of modern-day technological systems including smartphones, computers, vehicles and home appliances.

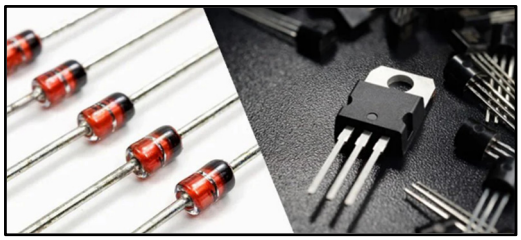
(i) Outline **two** advantages of using semiconductor components in electronic circuits.

(ii) Distinguish, with examples, between conductors, insulators and semiconductors.

(c) Transistor and diode operations are essential in semiconductor technology.

(i) Outline the function of a diode and the function of a transistor.

(ii) Describe the structure and operation of a transistor.



diodes *transistors*

(d) During production, semiconductive materials are sliced in thin wafers, polished and fabricated.

Describe the process of *doping* in semiconductor production.

(e) Outline the environmental impact of the production of semiconductor chips, referring to **each** of the following:

(i) Use of precious metals.

(ii) Disposal of electronic waste after use.

Question 3. **(50 marks)**

(a) Motorcycle engine components, such as the crankshaft shown, are typically forged from alloyed steel. During manufacture they undergo material testing to evaluate properties such as hardness and tensile strength.

(i) Explain the term *material hardness*.

(ii) Describe, with the aid of a diagram(s), the Vickers hardness test, with reference to:
- indenter shape
- test procedure
- hardness calculation.

(iii) Explain how torsional forces may affect the lifespan of the crankshaft.

(b) The following results were obtained from a tensile test on the alloy steel crankshaft.

Stress (N/mm^2)	44	110	160	220	264	300	330	340	352
Strain (×1000)	0.5	1.25	1.8	2.5	3.0	3.75	5.0	5.75	7.5

(i) Using the graph paper supplied, plot the stress-strain graph for the alloy.

(ii) Calculate Young's Modulus of Elasticity for the alloy.

(iii) Distinguish, with the aid of diagrams, between *ductile fracture* and *brittle fracture* in tensile testing.

(c) The motorcycle sprocket shown is subject to non-destructive testing (NDT) and quality control checks during manufacture.

(i) Explain the importance of quality control (QC) in the production of motorcycle components.

(ii) Describe, with the aid of a suitable diagram(s), the process of magnetic particle testing.

Question 4. **(50 marks)**

(a) The table below describes heat treatments applied to high-carbon steel axes A and B, used in the sport of axe throwing.

Axe **A**	Heated to 900°C and cooled in air
Axe **B**	Heated to 900°C and quenched in cold water

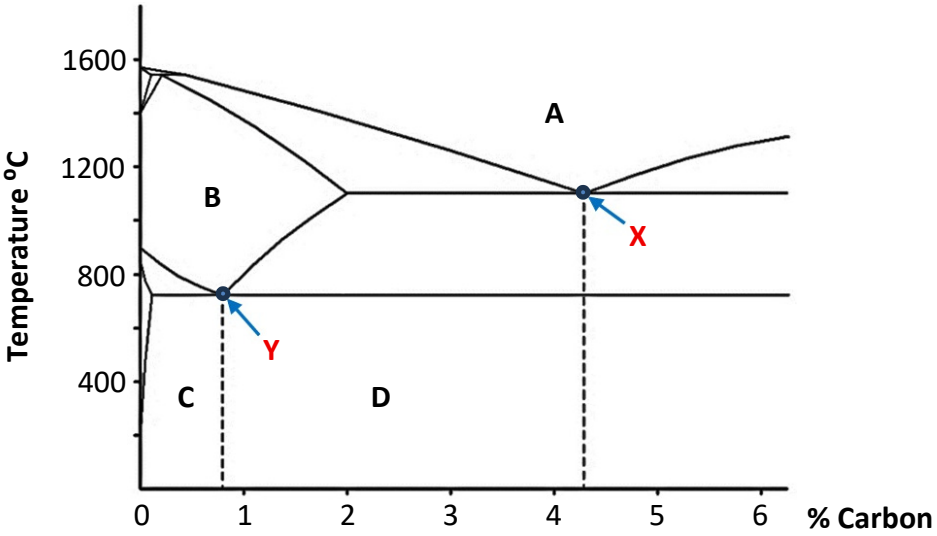
(i) Compare the material properties of axe **A** and axe **B** after cooling.

(ii) Identify which axe would be more suitable for competitive axe throwing **and** justify your choice.

(iii) Outline **two** reasons for tempering axe **B** after quenching.

high-carbon steel axe

(b) A simplified portion of the iron-carbon equilibrium diagram is shown.

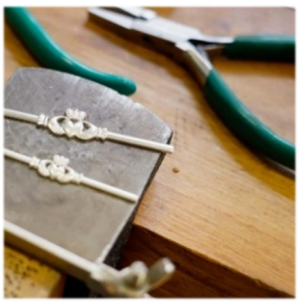


(i) Identify the regions **A**, **B**, **C** and **D** shown.

(ii) Identify and explain the significance of point **X** and point **Y** on the diagram.

(iii) Describe, with the aid of a diagram, **one** suitable method of accurately measuring furnace temperature when heat treating steel.

(c) Answer **any two** of the following:



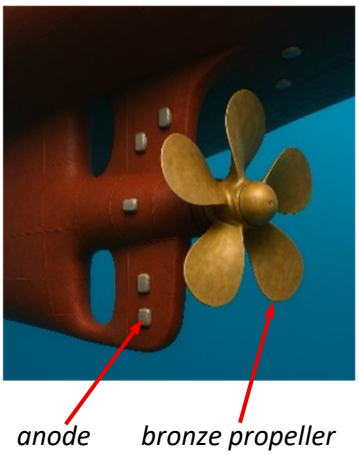
(i) Explain **two** reasons why silver is usually annealed during jewellery manufacture.

(ii) Identify **two** safety hazards associated with the flame hardening process.

(iii) Outline **two** suitable applications of cast iron and justify your choices.

Question 5. **(50 marks)**

(a) The hull of a cargo ship is shown, including a bronze propeller and attached anodes.



(i) Outline **two** reasons why bronze is suitable for the manufacture of the ship's propeller.

(ii) Describe the principle of sacrificial protection in relation to the bronze propeller shown.

(iii) Explain why regular inspection or replacement of the anodes is necessary in marine environments.

(b) The table shows the solidification temperatures for various alloys of metal **A** and metal **B**.

% of metal B in alloy	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Start of solidification (°C)	1083	1160	1220	1270	1320	1350	1380	1400	1430	1440	1453
End of solidification (°C)	1083	1080	1090	1110	1140	1170	1220	1270	1330	1380	1453

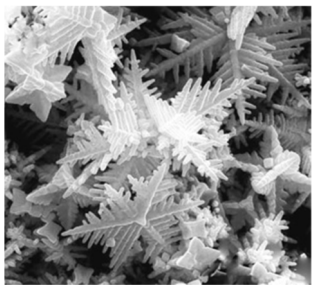
Using the graph paper supplied:

(i) Draw the equilibrium diagram according to the given data **and** label the liquidus and solidus lines.

(ii) Determine from the diagram the ratio of the phases at **1250°C** for the alloy with **50%** metal **B**.

(iii) Sketch the cooling curve for the alloy with **20%** metal **B**, referring to the solidification temperatures in the table above.

(c) Answer **any two** of the following:



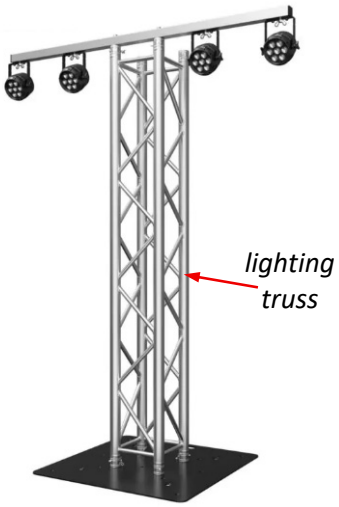
(i) Describe, with the aid of diagrams, the process of dendritic growth.

(ii) Describe, with the aid of diagrams, **any two** crystal point defects which may occur during the solidification process.

(iii) Outline the effects of cold working on the material properties and internal structure of metals.

Question 6. **(50 marks)**

(a) Stage rigging, such as the lighting truss shown, is usually fabricated from tubular aluminium.



(i) Outline **two** reasons why tubular aluminium is suitable for the manufacture of the lighting truss shown.

(ii) Select a suitable welding process for the fabrication of the aluminum truss and give **one** reason for your choice.

(iii) Describe, with the aid of a diagram(s), the key principles of the welding process selected.

(b) Answer **any three** of the following:

(i) Explain, with examples, the difference between consumable and non-consumable electrodes used in welding.

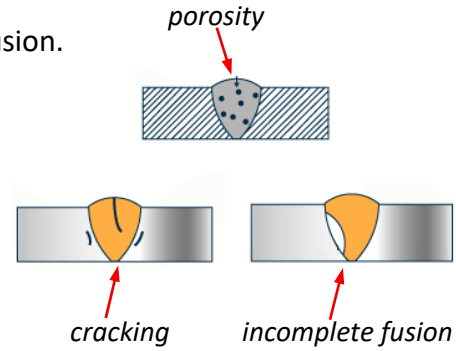
(ii) Identify **two** advantages of using the welding helmet shown opposite.

(iii) Outline **two** reasons for using a jig during a welding procedure.

(iv) Identify **three** safety features integrated into oxy-acetylene welding equipment.

(v) Explain **two** advantages of laser beam welding (LBW) over traditional welding methods.

(c) Welding defects include porosity, cracking and incomplete fusion.



(i) Explain the meaning of weld porosity **and** outline **two** methods used to prevent weld porosity occurring.

(ii) Outline why weld cracks **or** incomplete fusion may occur during welding.

OR

(c) The *Dexai robotic arm* shown is a collaborative robot used in commercial kitchens to automate food preparation tasks.

Dexai robotic arm

(i) Identify **two** other areas where robotic arms are used in modern engineering industries.

(ii) Explain the following terms in relation to robotic arm control:

- Working envelope
- Degrees of freedom.

Question 7. **(50 marks)**

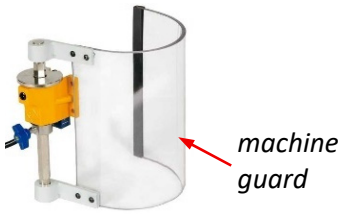
(a) The outdoor goal posts shown consist of thermoplastic tubing and corner joints.

(i) Name a **suitable** process used to manufacture the thermoplastic tubing **and** a **suitable** process used to manufacture the corner joints.

(ii) Describe, with the aid of a diagram(s), the polymer manufacturing process you have selected for the thermoplastic tubing.

(iii) Explain the function of *polymer stabilisers* in the manufacture of the goal posts shown.

(b) Answer **any three** of the following:



(i) Describe **two** advantages of using polycarbonate in the manufacture of the machine guard shown.

(ii) Distinguish between polymer recycling and polymer upcycling, and give an example of each.

(iii) Explain the difference between linear and cross-linked polymer structures.

(iv) Explain the term *copolymer*.

(v) Outline **two** reasons why polylactic acid (PLA) is suitable for use in the manufacture of agricultural products such as the mulch film shown.

(c) The saddle seat shown is made from an elastomer material, thermoplastic polyurethane (TPU) and is 3D-printed.

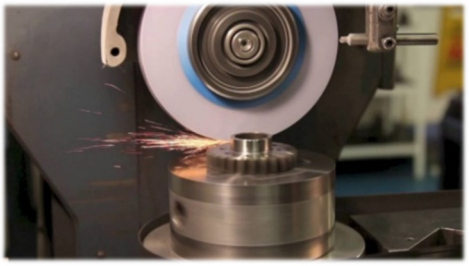
(i) Explain the term *elastomer*.

(ii) Describe, with the aid of a diagram, the internal structure of elastomers.

(iii) Describe **two** advantages of using 3D-printed elastomer in the production of the saddle seat shown.

Question 8. **(50 marks)**

(a) Grinding wheels are widely used in engineering to cut, shape and finish materials. Over time, issues like loading and glazing can affect their performance.



(i) Describe, with the aid of a diagram(s), the difference between loading and glazing of grinding wheels.

(ii) Explain the purpose of wheel dressing in grinding operations.

(iii) Outline **two** safety precautions to be observed when operating a grinding machine.

(b) Answer **any three** of the following:

(i) Distinguish between *forming* and *generating* using labelled diagrams to support your answer.

(ii) Identify **two** hazards associated with the use of coolants in machining.

(iii) Outline **two** methods used to prevent a built-up edge when machining.

(iv) Describe, with examples, the difference between a four-jaw independent chuck and a three-jaw self centring chuck.

(c) Face milling is a common machining process.

face milling cutting tool

(i) Explain, with the aid of a diagram(s), the process of face milling.

(ii) Describe the effects of cutting fluids on:

- Material surface finish
- Cutting-tool life.

OR

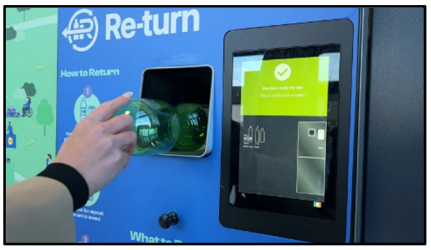
(c) CNC machines have revolutionised engineering practices in recent decades.

Describe **each** of the following CNC features:

- G-code
- Stepper motor
- Leadscrew
- Control panel.

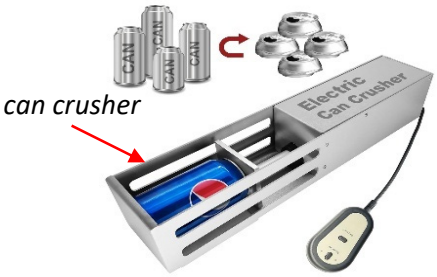
Question 9. **(50 marks)**

(a) Reverse vending machines provide an automated method for collecting, sorting and handling the return of used beverage containers for recycling.



(i) Describe, with the aid of a diagram(s), a conveyor mechanism which may be used to collect and sort materials in a reverse vending machine.

(ii) Describe a suitable mechanism that could be used to operate the can crusher shown opposite.



(b) Answer **any three** of the following:

(i) State **two** advantages of a toothed belt drive over a chain drive.

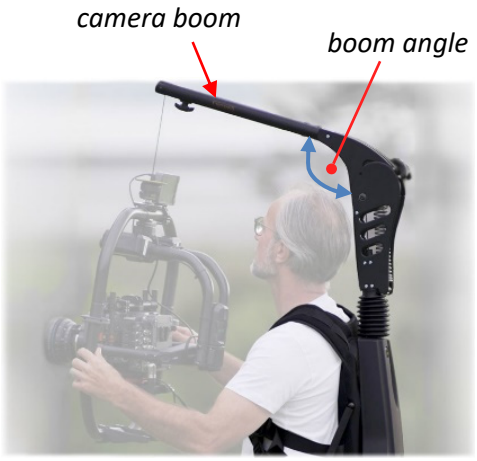
(ii) Outline the function of the *fulcrum* in relation to levers.

(iii) Identify the mechanical coupling shown opposite **and** state **one** suitable application of the coupling.

(iv) Explain the purpose of the colour-coded bands found on a resistor.

(v) Describe, with the aid of a diagram, the operation of a worm and gear mechanism.

(c) The *Easyrig* camera system shown opposite is a device designed to assist camera operators during filming.



Easyrig camera system

(i) Describe, with the aid of a diagram(s), a suitable mechanism that would allow adjustment of the camera boom angle.

(ii) State **two** features on an *Easyrig* system that will assist the camera operator.

OR

(c) The outdoor wall light shown includes components such as a solar panel, rechargeable battery and a light-dependent resistor (LDR).

wall light

(i) Describe **two** energy conversions that take place in the wall light shown.

(ii) Outline the purpose of the light-dependent resistor (LDR) in the wall light shown.

Leaving Certificate – Higher Level

Engineering – *Materials and Technology*

Thursday, 4 June
Morning 9:30 – 12:30