



Coimisiún na Scrúduithe Stáit State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2024

ENGINEERING – MATERIALS AND TECHNOLOGY

(Higher level – 300 marks)

THURSDAY, 6 JUNE

MORNING 9:30 – 12:30

The 2024 examination papers were adjusted to compensate for disruptions to learning due to COVID-19. This examination paper does not necessarily reflect the same structure and format as the examination papers of past or subsequent years.

INSTRUCTIONS

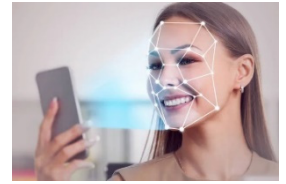
1. Answer **any SIX** questions.
2. All questions carry equal marks.
3. All answers must be written in ink on the answer book supplied.
4. Diagrams should be drawn in pencil.
5. Squared paper is supplied for graphs, as required.
6. Please label and number carefully each question attempted.

Question 1.

(50 marks)

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

- (a) Outline **one** advantage and **one** disadvantage of facial recognition technology.



- (b) Identify **two** hazards associated with the use of adhesives in engineering.

- (c) In precision measurement, explain what is meant by *parallax error*.



- (d) Outline **two** reasons why a computer standing desk may be used in industry.

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

(i) Viktor Kaplan

(ii) James Watt

(iii) Gaston Planté.

- (f) Describe **two** important material properties to be considered when selecting a suitable material for a mouth guard.



- (g) Identify **two** reasons for the selection of aluminium to manufacture the roof bar shown.



- (h) The roof bar uses an elastomer strip to provide a grip for carrying items. Explain the term *elastomer*.

- (i) Describe briefly the process of *metal extrusion* used to manufacture the aluminium profile of the roof bar.

- (j) Compare the indenters used in **both** the Brinell and the Vickers hardness tests.

- (k) Differentiate between pyrometallurgy and hydrometallurgy.

- (l) Outline **one** advantage and **one** disadvantage of cordless power tools.

- (m) Solar panels may be tilted to optimise the capture of solar energy. Suggest a suitable mechanism which could be used to tilt a solar panel.



Question 2.

Answer **all** of the following:

(50 marks)

- (a) Transportation of goods around the world has been transformed by shipping. In 2021, it was estimated that 80% of all goods by volume were transported by container ships.

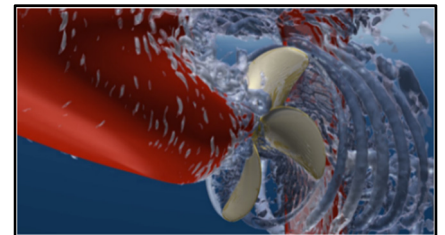


- (i) Outline **two** reasons for the extensive use of container ships in the movement of goods.
- (ii) Describe **two** hazards that container ships must overcome as they move across the oceans.

- (b) Container ships are generally described in terms of TEU capacity.

- (i) Explain the term TEU.
- (ii) Distinguish between the following container ships: Feeder, Panamax and Ultra Large Container Vessel (ULCV).

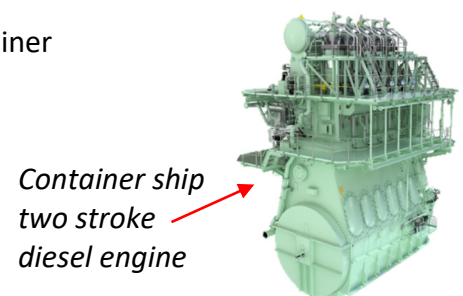
- (c) (i) Container ships are often driven by cast bronze propellers which may be up to 10m in diameter. Outline **two** reasons for the use of bronze in the propellers of container ships.



- (ii) Describe, with the aid of diagram(s), how container ship stability is maintained making reference to *centre of gravity* **and** *shape of the hull*.

- (d) (i) Discuss the use of the two-stroke diesel engine for container ships with reference to speed **and** propulsion.

- (ii) Outline, with the aid of a diagram(s), **one** method used in steering a container ship.



- (e) Discuss the environmental impact of **any two** of the following with regard to container ship technology:

- (i) Ballast water management.
- (ii) Oil leakage.
- (iii) Emissions.

Question 3.

(50 marks)

- (a) The shin guards shown are custom-made using 3D body scanning software and are manufactured from carbon fibre material. The materials used in a shin guard are subject to toughness testing prior to manufacture.



- (i) Outline **two** benefits of custom-made carbon fibre shin guards.
- (ii) Define the term *material toughness*.
- (iii) Describe, with the aid of a diagram(s), a testing procedure used to determine the toughness of a material.

- (b) The results shown were obtained from a tensile test on an aluminum alloy specimen.

Stress (N/mm ²)	45	90	135	200	275	308	335	345	340
Strain (×1000)	0.50	1.00	1.50	2.25	3.25	4.00	5.00	6.50	7.50

- (i) Using the graph paper supplied, plot the stress-strain diagram for the alloy.
- (ii) Calculate Young's Modulus of Elasticity for the alloy.
- (iii) Describe, with the aid of a diagram(s), the following terms related to tensile testing:
 - necking
 - cup and cone fracture.

- (c) An aluminium alloy is used to produce a linkage arm for the landing gear of an aircraft.

- (i) Outline **two** reasons why non-destructive tests are used during the production of the linkage arm.
- (ii) Describe, with the aid of a diagram(s), **one** suitable non-destructive test that may be used to examine the aluminium linkage arm for internal flaws.



Aluminium linkage arm

Question 4.

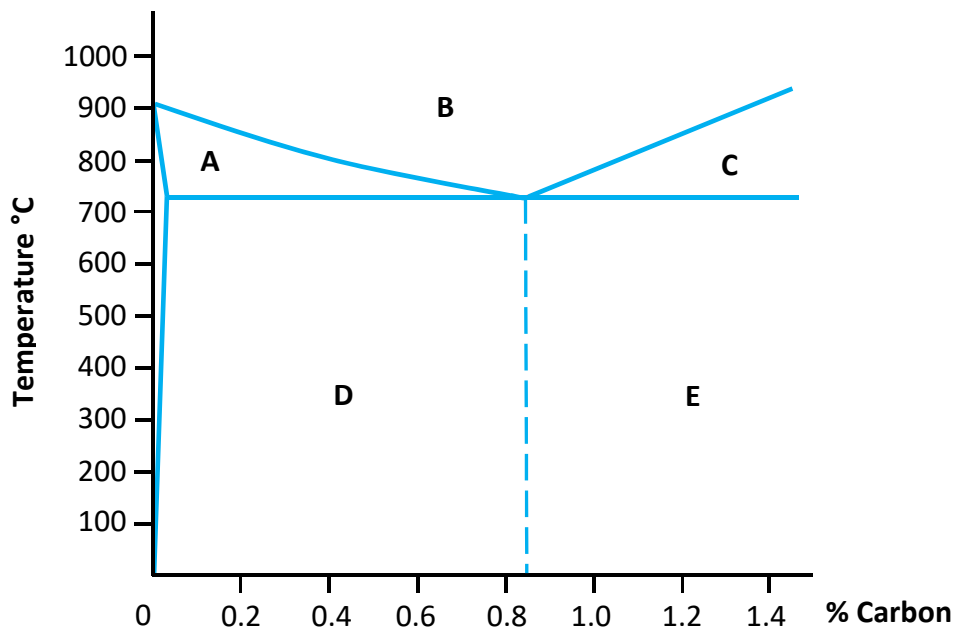
(50 marks)

- (a)** High performance brake discs are subject to heat treatments such as hardening and tempering during manufacture.

- (i)** Outline the purpose of hardening **and** tempering the brake disc shown.
- (ii)** Describe, with the aid of a diagram(s), a suitable hardening heat treatment process for the brake disc.



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

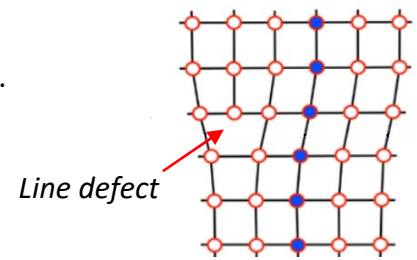


- (i)** Identify the regions labelled **A**, **B**, **C**, **D** and **E**.
 - (ii)** Explain how steel containing 0.6% carbon is annealed.
 - (iii)** Outline **two** benefits of annealing 0.6% carbon steel.
- (c)** Answer **any two** of the following:
- (i)** Explain the effects of work hardening on a material.
 - (ii)** Identify **two** safety hazards associated with the flame hardening process.
 - (iii)** Distinguish between eutectic point and eutectoid point.

Question 5.

(50 marks)

- (a) (i) Describe, with the aid of diagram(s), the various stages of dendritic growth during the process of metal solidification.
- (ii) Outline the impact of a line defect in the crystal structure of a material.



- (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)	270	332	400	445	492	524	552	580	603	618	630
End of solidification (°C)	270	272	280	300	318	340	368	404	449	510	630

Using the graph paper supplied:

- (i) Draw the equilibrium diagram according to the given data **and** label the liquidus and solidus lines.
- (ii) Sketch the cooling curve for the alloy with **30%** metal **B**, referring to the solidification temperatures in the table above.
- (iii) State the melting point of metal **A** **and** the melting point of metal **B**.
- (c) Answer **any two** of the following:
- (i) Describe the principle of *sacrificial protection* in relation to offshore wind farms.
- (ii) Other than sacrificial protection, suggest **two** suitable methods that could be used to protect steel from the possible corrosive effects of the environment.
- (iii) Explain why FCC crystalline structures are most associated with ductility in metals.



Question 6.

(50 marks)

(a) The pressure tank shown is fabricated from sheet stainless steel, which is rolled into shape and then welded using tungsten inert gas (TIG) welding.

- (i) State **two** reasons why tungsten inert gas (TIG) welding is suitable for the fabrication of the pressure tank shown.
- (ii) Describe, with the aid of a diagram(s), the process of tungsten inert gas (TIG) welding.



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

- (i) Suggest a suitable method to protect against **each** of the following during manual metal arc (MMA) welding:
 - Electric Shock
 - Intense light
 - Welding fumes.
- (ii) Describe the process of resistance spot welding.
- (iii) Explain, with an example, the term *inert gas* as used in metal inert gas (MIG) welding.
- (iv) Identify a suitable Non-Destructive Test (NDT) for the inspection of porosity in welds.
- (v) Outline the function of the *transformer* in manual metal arc (MMA) welding.

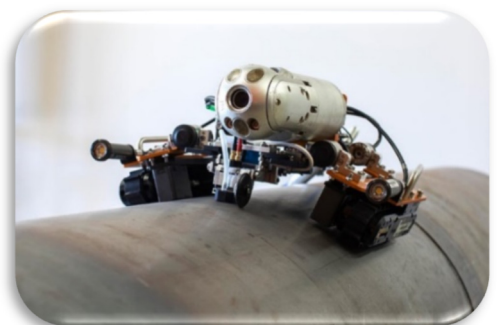
(c) Describe, with the aid of suitable diagram(s), oxy-acetylene welding with reference to **each** of the following:

- equipment used
- flame types
- integrated safety features
- applications.

OR

(c) Remote Visual Inspection (RVI) technology, such as the crawler robot shown, is used to assist engineers in the inspection and repair of welded pipelines.

- (i) Outline **two** benefits of using robots to carry out the inspection of pipelines.
- (ii) Identify **two** other possible applications of Remote Visual Inspection technology.



Question 7.

(50 marks)

(a) Thermoplastic materials such as polypropylene and PVC are used in the manufacture of the hose reel cover and hose pipe shown.

- (i) Name a process used to manufacture the cover **and** name a process used to manufacture the hose pipe.
- (ii) Describe, with the aid of a diagram(s), the principle of operation for the manufacturing process used to manufacture the hose pipe.
- (iii) Identify a suitable polymer additive which is used to improve the properties of the hose pipe for **each** of the following:
 - increased flexibility
 - greater resistance to UV rays.

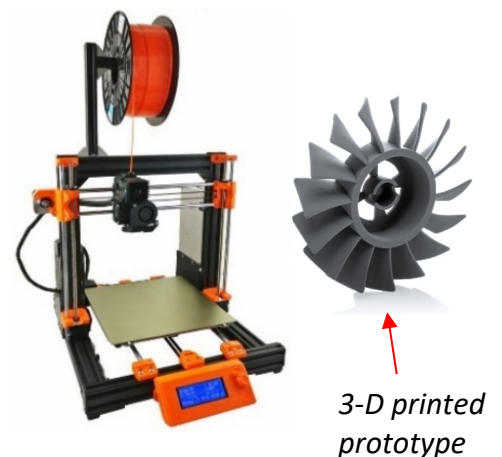


(b) Answer **any three** of the following:

- (i) Give **one** suitable example where a plastic product may be upcycled.
- (ii) Explain the glass transition temperature of polymers.
- (iii) Describe the process of polymer lamination.
- (iv) Outline, with the aid of a diagram(s), the internal structure of thermosetting polymers.
- (v) Describe the manufacturing process of blow moulding.

(c) Automotive and aerospace industries commonly use bioplastics such as polylactic acid (PLA) to 3D print prototypes.

- (i) Explain the term *bioplastic*.
- (ii) Describe **three** advantages of using rapid prototyping techniques in the design of new products.

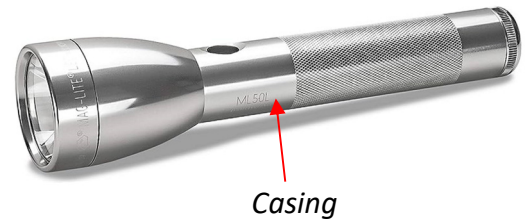


Question 8.

(50 marks)

(a) The aluminium casing of the handheld torch shown may be turned on a centre lathe.

- (i) Describe, with the aid of a diagram(s), **three** operations used in making the torch casing on a centre lathe.
- (ii) Identify **two** factors that influence material surface finish when machining on a lathe.



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

- (i) Differentiate between *forming* and *generating* when machining.
- (ii) Outline the purpose of *balancing* a grinding wheel.
- (iii) Explain, with the aid of a diagram(s), the *clearance angle* and *rake angle* on a single point cutting tool.
- (iv) State **one** advantage and **one** disadvantage of using a magnetic chuck on a surface grinding machine.
- (v) Explain the difference between a *countersunk* hole and a *counterbored* hole in drilling.

(c) A sealed lubrication system is shown for the rotating shaft in a metal cutting machine.

- (i) Outline **two** reasons why a sealed lubrication system is used in the rotating shaft shown.
- (ii) Identify **any two** lubricants commonly used when machining.



OR

(c) Both CNC milling machines and laser cutting machines can be used to create detailed profiles and designs on a variety of materials.

- (i) Explain the difference between a CNC milling machine and a laser cutting machine.
- (ii) Outline **two** safety features integrated into computerised manufacturing machines.



Question 9.

(50 marks)

- (a) The sliding doors shown use a motorised pulley and belt mechanism to automatically open and close the doors.
- (i) Describe, with the aid of a diagram(s), how the pulley and belt mechanism opens and closes the doors.
 - (ii) Describe, with the aid of a diagram(s), an alternative mechanism used to open and close the doors.



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

- (i) Describe the operation of a Light Dependent Resistor (LDR).
- (ii) Identify the mechanism shown opposite **and** give **one** suitable use for the mechanism.
- (iii) State **two** advantages of using helical gears over spur gears.
- (iv) Outline the operation of a clutch mechanism.
- (v) Describe, with the aid of a diagram(s), the principle of operation of a relay.



- (c) Racing car seats are fitted with custom designed safety harnesses.

- (i) Describe **two** essential features associated with the design of a safety harness for a racing car driver.
- (ii) Suggest suitable materials used to manufacture a safety harness for a racing car driver. Justify your material selection.



OR

- (c) Schools and public buildings are upgrading their lighting control systems to include LED lighting and Passive Infrared (PIR) motion sensors.
- (i) State **two** benefits associated with the use of LED lights.
 - (ii) Identify **two** advantages of using PIR motion sensors in school buildings.



Leaving Certificate – Higher Level

Engineering – *Materials and Technology*

Thursday 6 June

Morning 9:30 – 12:30