Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2011

ENGINEERING – MATERIALS AND TECHNOLOGY

(Higher Level – 300 marks)

THURSDAY 9 JUNE, MORNING 9:30 – 12:30

INSTRUCTIONS

1. Answer **Sections A and B of Question 1** and **FOUR** other questions.

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

3. Diagrams should be drawn in pencil.

4. Graph paper is supplied for diagrams and graphs as required.

5. Please label and number carefully each question attempted.

Question 1. **(100 marks)**

Section A – 50 Marks

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

(a) Describe the method of ore dressing shown opposite.

(b) Explain the term *co-polymer*.

(c) Identify **any three** barrier materials that may be applied to mild steel to protect against corrosion.

(d) Outline **three** factors to be observed in the safe use of adhesives.

(e) Describe **any two** properties of polypropylene that make it suitable as a material in the manufacture of stacking chairs for schools and colleges.

(f) Differentiate, with examples, between an electrical insulator and an electrical conductor.

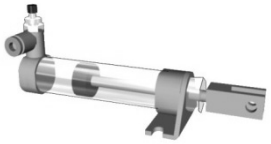
(g) The innovative Irish designer, Eileen Gray, designed this table with a tubular steel frame. It is regarded as a design classic. Outline **two** reasons why tubular steel is a suitable material for this table.

(h) Select **any two** of the abbreviations shown and explain their meaning:
(i) LCD **(ii)** PCB **(iii)** HSS **(iv)** DPDT switch.

(i) Distinguish between a *clearance* fit and an *interference* fit.

(j) What contribution did **any one** of the following make to technology?
(i) Trevor Baylis **(ii)** Charles Babbage **(iii)** Frank Whittle.

(k) Identify **any one** of the pneumatic components illustrated.

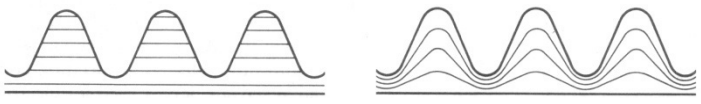


(i)

(ii)

(l) Describe the use of flashback arrestors in oxy-acetylene welding equipment.

(m) Compare the properties of the thread machined at **(i)** and the properties of the thread rolled at **(ii)** shown below.



(i) **(ii)**

Section B – 50 Marks

Answer **all** of the following:

(n) The iconic design of the Spittelau incineration plant in Vienna as shown, is widely regarded as being both innovative and visually interesting.
The following are some of the pollution concerns that need to be addressed in relation to incineration technology:

(i) Volume of waste for landfill;
(ii) Hazard of 'fly' ash;
(iii) Impact on recycling rates.

Briefly describe **each** of these pollution concerns.

(o) Dioxins are a group of 200 or so chlorinated organic compounds and are a by-product of incineration and backyard burning of domestic waste.

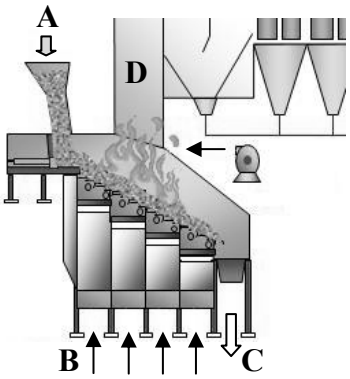
(i) Outline **two** ways that dioxins may affect the health of residents who live close to incineration plants.

(ii) Explain how the production of dioxins can be minimised.

(p) Waste incineration technology uses the combustion process under controlled conditions to convert waste materials to inert gases and ash.
Describe **any three** of the combustion elements outlined below:

- Temperature
- Fuel
- Time
- Oxygen.

(q) Describe the principles of operation of the moving grate incinerator, as shown in the diagram. Make reference to waste input and the processing of incinerator products.



(r) Explain **any two** of the following:

(i) The benefits of waste-to-energy (WtE/W2E) technologies;
(ii) Some of the issues involved when locating incinerator plants;
(iii) Incineration by the *rotary kiln* method.

Question 2. **(50 marks)**

(a) **(i)** Distinguish between *metal fatigue* and *metal creep*.

(ii) Compare the two hardness tests represented in diagrams **A** and **B**, making reference to:

- name of tests
- method of measurement
- test-material suitability.

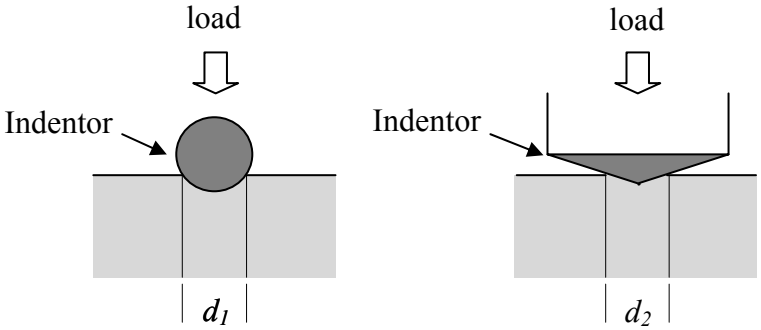


Diagram **A** Diagram **B**

(b) The following results were obtained from a tensile test on an aluminium alloy.

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

Using the graph paper supplied, plot the stress-strain graph and determine:

(i) Young's modulus of elasticity for the alloy;

(ii) The 0.1% proof stress.

(c) **(i)** Non-destructive tests (NDTs) are generally more expensive than other forms of metal testing. Explain **two** reasons for the use of NDTs in industry.

(ii) Describe, with the aid of a suitable diagram, **one** non-destructive test that uses ultrasonic principles as a method of flaw detection.

Question 3. **(50 marks)**

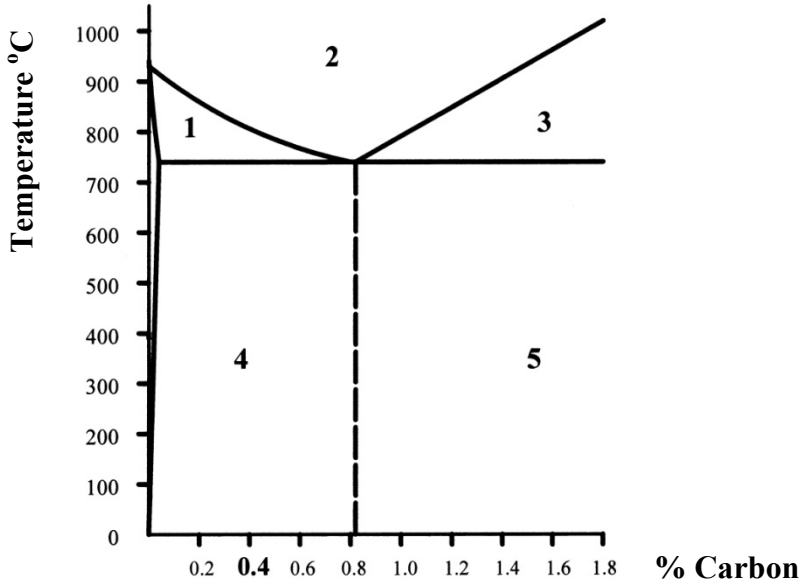
(a) Answer **any two** of the following:

(i) Describe, with the aid of a suitable diagram, the induction hardening process;

(ii) Distinguish between the properties of grey cast iron and white cast iron;

(iii) Explain the function of stress relieving in metals.

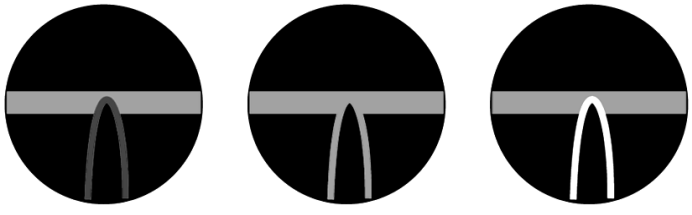
(b) A simplified section of the iron-carbon equilibrium diagram is shown.



(i) Identify the regions represented at **1**, **2**, **3**, **4** and **5**.

(ii) Outline the effect of cooling **0.4%** carbon steel quickly from **900 ºC**.

(c) The diagrams shown below represent a series of readings from a pyrometer.



(i) Name this pyrometer and state its function.

(ii) Describe the principle of operation of the pyrometer, making reference to diagrams **A**, **B** and **C**.

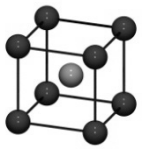
Question 4. **(50 marks)**

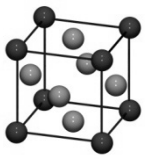
(a) Explain **any two** of the following:

(i) Allotropy;

(ii) Interstitial solid solution;

(iii) The difference between amorphous structures and crystalline structures;





(iv) The degree of brittleness in body-centred cubic (bcc) structures and the degree of brittleness in face-centred cubic (fcc) structures.

(b) The table shows the solidification temperatures for the various alloys of metal A and metal B. The melting point of **metal A** is **1083 ºC** and the melting point of **metal B** is **1453 ºC**.

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

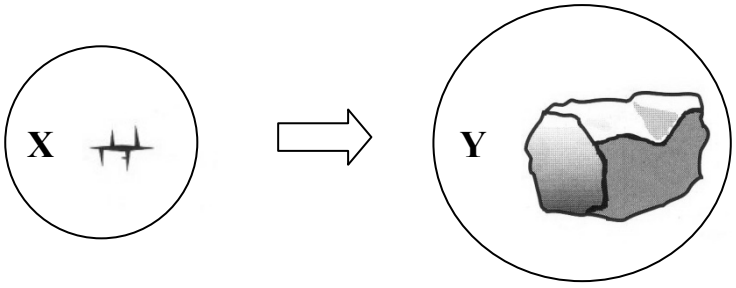
Using the graph paper supplied:

(i) Draw the thermal equilibrium diagram according to the given data;

(ii) Label the main features of the diagram;

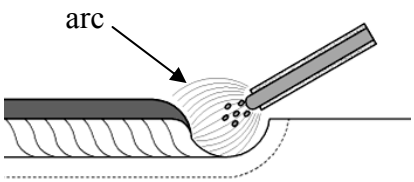
(iii) Determine, from the diagram, the ratio of the phases at **1250 ºC** for the alloy of **50%** metal B.

(c) Outline the various stages of solidification as a metal cools, from **X** to the crystal at **Y**, as shown below.



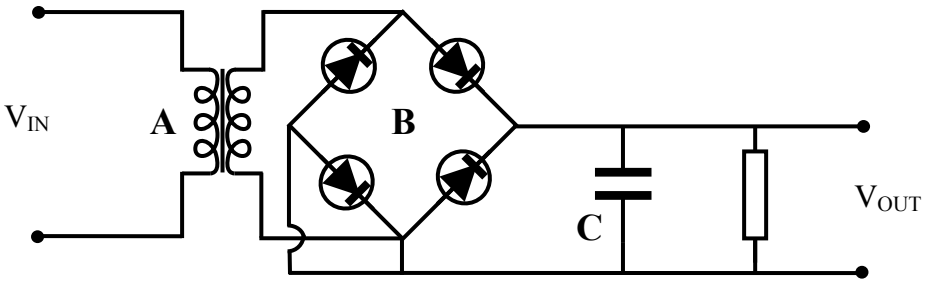
Question 5. **(50 marks)**

(a) The process of manual metal arc welding (MMA) is illustrated.



(i) Describe the principles of operation of MMA welding.

(ii) Identify the **three** main parts **A**, **B** and **C** of the MMA welding circuit shown and state the function of each part.



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

(i) Describe **three** important safety features that minimise electrical hazards associated with manual metal arc welding;

(ii) Outline **three** methods of preventing atmospheric contamination of the weld area;

(iii) Why is tungsten inert gas welding suitable for welding aluminium?

(iv) Explain the function of dissolved acetylene in oxy-acetylene welding.

(c) Describe, with the aid of a suitable diagram, the main features of **one** of the following:

(i) Seam resistance welding;

(ii) Submerged arc welding (SAW).

OR

(c) **(i)** Explain the robotic control terms:

- *work envelope* and
- *degree of freedom*.

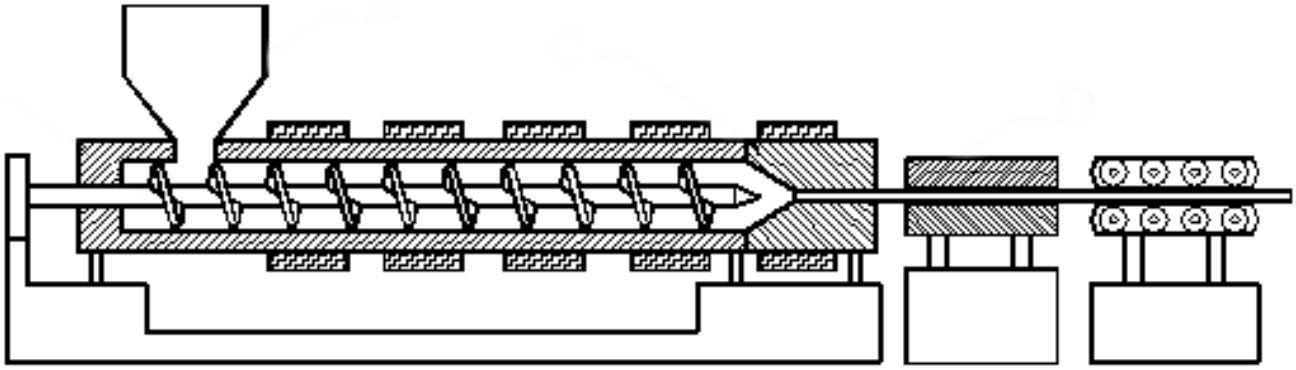
(ii) Outline **one** advantage of the use of stepper motors rather than DC motors in robotic control.

Question 6. **(50 marks)**

(a) **(i)** Describe, with the aid of diagrams, the addition polymerisation process.

(ii) Name **one** polymer material produced by addition polymerisation.

(b) With reference to the polymer manufacturing process shown in the diagram, answer **each** of the following:



(i) Name the process **and** describe the principle of operation;

(ii) State the type of polymer used in this process;

(iii) Identify **one** component produced by this process.

(c) Explain the function of **any three** of the following polymer additives:

(i) Plasticiser;

(ii) Filler;

(iii) Lubricant;

(iv) Stabiliser;

(v) Pigment.

Question 7. **(50 marks)**

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

(i) Identify **two** safety precautions that reduce the formation of a *built-up edge* while turning on a centre lathe;

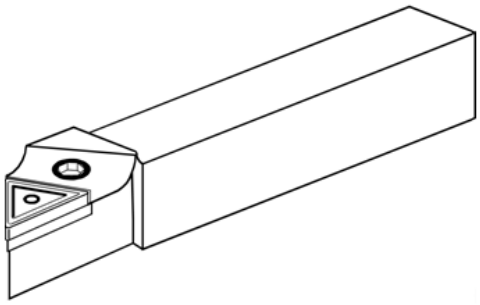
(ii) Distinguish between oblique cutting and orthogonal cutting;

(iii) Explain **one** main function of a feeler gauge;

(iv) Describe the main features of a Morse taper sleeve;

(v) State the function of a reamer.

(b) During the production of tungsten carbide cutting-tool inserts, cobalt and tungsten powder are mixed with cemented carbide and pressed into shape.

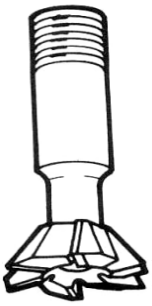


(i) Outline **two** reasons for using tungsten carbide cutting tools rather than high-speed steel cutting tools.

(ii) Explain **one** advantage of using interchangeable tool inserts.

(c) Describe, with the aid of diagrams, a suitable cutting operation for **each** of the milling cutters shown.

(i)



(ii)

OR

(c) **(i)** Describe **three** safety features integrated into the design of a CNC lathe or a CNC milling machine.

(ii) Explain the role of simulation in CNC machining.

Question 8. **(50 marks)**

(a) Name and describe the operation of **any one** of the mechanisms shown.

(i)

(ii)

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

(i) The advantages of using vee-pulley belts over flat belts;

(ii) Chain and sprocket;

(iii) Toggle mechanism;

(iv) Light dependent resistor (LDR);

(v) The functions of the electronic transistor.

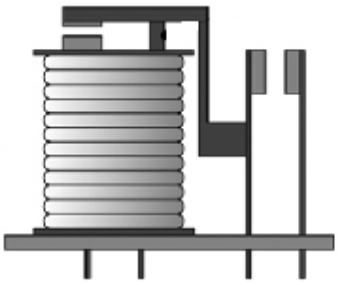
(c) Describe, with the aid of a suitable diagram, a mechanism to control the steering of the go-kart shown.

OR

(c) The electronic component shown is commonly used as a switching device:

(i) Identify the component shown.

(ii) Describe the operation of this component, making reference to the coil, armature and contacts.



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