Diploma Programme
Programme du diplôme
Programa del Diploma

Design technology
Higher level and standard level
Paper 2

Friday 4 May 2018 (afternoon)

1 hour 30 minutes

Candidate session number

Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer one question.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[50 marks]**.

2218 – 6203

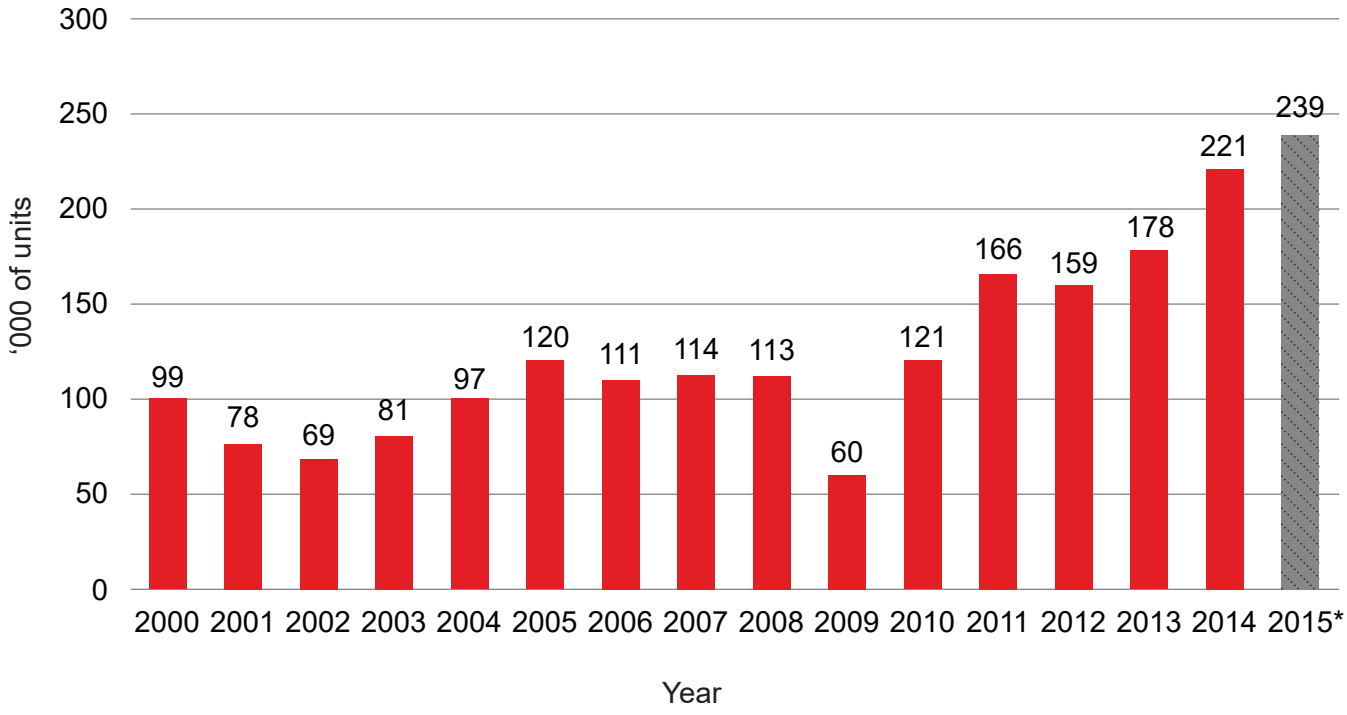
20 pages

Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

1. A recent study estimated that 239 000 industrial robots were used globally in 2015, see **Figure 1**. The study indicated that the growth was particularly rapid in China where the number of robots used increased by 16 % from 2014 to 2015.

Figure 1: Worldwide supply of industrial robots 2000–2015



*preliminary result

[Source: IFR World Robotics 2017]

Rapid advances in robot technology bring both advantages and disadvantages. Another report stated that 45 % of American jobs are at high risk of being taken by robots within the next twenty years.

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(Question 1 continued)

(a) (i) Define the term *first generation robot*. [1]

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(ii) Describe the work envelope of a robot. [2]

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(b) (i) List **two** advantages of using robotics in mass production. [2]

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(ii) Outline how systems such as computer aided manufacturing (CAM) can contribute to improving the rate of production. [2]

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(Question 1 continued)

(c) (i) Outline how design for disassembly can minimize waste. [2]

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(ii) Explain the possible negative social effects of automation in a production system. [3]

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(Question 1 continued)

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Figure 2: A robotic arm created the shape of the mould for the Kuskoa Bi chair

Figure 3: The Kuskoa Bi chair

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(d) (i) Define the term *renewable resource*. [1]

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(Question 1 continued)

(ii) Outline **one** advantage of using biodegradable plastics in the Kuskoa Bi chair. [2]

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(e) (i) Outline which type of physiological factor data would be used in the design of the Kuskoa Bi chair. [2]

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(ii) The objectives for Green design fall into three categories:
- materials
- energy
- pollution and waste.

Explain how the use of bioplastics in the Kuskoa Bi chair fit into **one** of these categories. [3]

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2. Many high-tech engineering companies are turning to 3D printing to manufacture components for applications that are subject to high stress and high temperature environments. General Electric (GE) are already using additive manufacturing techniques to produce fuel nozzles in the combustion system of their Leading Edge Aviation Propulsion (LEAP) jet engine range, that could not be made any other way. GE researchers recently completed a fully 3D printed, working mini jet engine prototype as a proof of concept, see **Figure 4**.

The team used Direct Metal Laser Melting (DMLM), which uses lasers to fuse thin layers of metal powder on top of each other to form the parts. The technique allowed for more complex and efficient parts with less material waste.

Turbines, such as in **Figure 5**, are required to work in very hostile environments. Most turbines are made from super alloys.

[Source: Adapted from GE Reports, "3D Printing: These Engineers 3D Printed a Mini Jet Engine, Then Took it to 33,000 RPM," Sep 5, 2016 by Mike Keller, https://www.ge.com/reports/post/118394013625/these-engineers-3d-printed-a-mini-jet-engine-then.]

Figure 4: The GE 3D printed working engine prototype.

Figure 5: An individual turbine blade

[Source: GE Aviation and Turbocam, Inc. - Additive Manufacturing]

(a) Outline why a super alloy is used to produce a turbine such as the one shown in **Figure 5**. [2]

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(Question 2 continued)

(b) Outline **two** advantages of using 3D printing to create the turbine blade shown in **Figure 5**. [2]

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3. Explain how copyright can be used as a strategy for the protection of intellectual property. [3]

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4. Explain how the mobile phone can be classified as disruptive innovation. [3]

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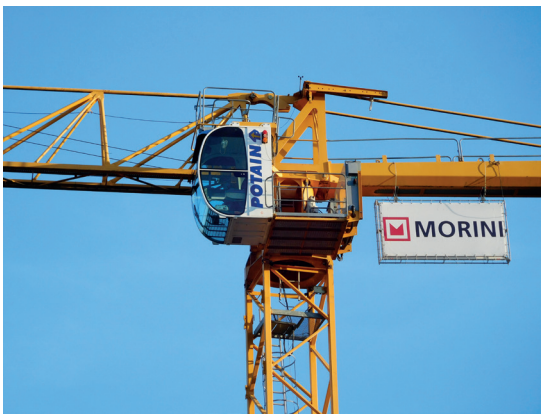
Section B

Answer **one** question. Answers must be written within the answer boxes provided.

5. There has been a significant increase recently in the number of very tall buildings (skyscrapers). For example, in Hong Kong there are 315 skyscrapers.

This has led to a corresponding increase in the number of people required to operate tower cranes, such as the example in **Figure 6**.

Figure 6: A cabin in a tower crane

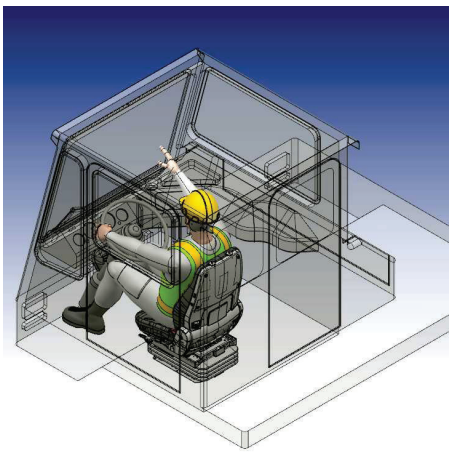


[Source: https://commons.wikimedia.org/wiki/File:Potain_tower_crane4_-_Cabin.jpg by Cjp24]

The cabins of these tower cranes may be as much as 200 metres above the height of the street. The designer must consider not only the safety of the worker, but also their comfort as this may affect their performance.

Some designers have used virtual prototyping, such as in **Figure 7**, in the development of these cabins.

Figure 7: A virtual prototype of a crane cabin



[Source: Image provided with kind permission from Ergo-link/Sun Group Design LLC]

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(Question 5 continued)

(a) Outline how anthropometric data can be used in the computer aided design (CAD) ergonomic software. [2]

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(b) Explain **one** benefit for production when computer aided design (CAD) is used in the design phase. [3]

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(Question 5 continued)

(c) Before creating the CAD model shown in **Figure 7**, the designers would have created a number of conceptual models.

Explain **two** advantages of using conceptual modelling prior to the development of a CAD model. [6]

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(Question 5 continued)

(d) Explain how the use of a digital human in **Figure 7** can help improve the design of the crane cabin with respect to comfort, safety **and** performance. [9]

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Figure 8: The Wakati One tent

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Figure 9: The Wakati power unit

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(Question 6 continued)

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(a) List **two** properties of ABS that make it suitable for use in the Wakati power unit. [2]

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(b) Rogers identifies five characteristics that affect the consumer's acceptance of an innovation. One of these characteristics is compatibility.

Explain how compatibility will affect consumer adoption of an innovation such as the Wakati One tent. [3]

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(Question 6 continued)

(c) Explain how injection moulding minimizes costs **and** waste during production of the Wakati power unit in **Figure 9**. [6]

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(Question 6 continued)

(d) Explain how the inventor is addressing need, price **and** marketing so that the Wakati One Tent can become a successful innovation. [9]

7. The Volkswagen (VW) Beetle is considered a design classic. In the 1999 car of the century competition it came fourth (after the Ford Model T, Mini and Citroen DS).

Since the production of the first car in 1941 the car has changed very little in appearance, see **Figure 10**. Initially the bodywork was made of steel, but more recently this has changed to a range of materials such as alloys, composites and plastics.

Figure 10: The VW Beetle 1941–2015

[Source: Andrew Bone https://www.flickr.com/photos/andreboeni/26393789835/]

[Source: PD-USGov]

Other materials that make up the VW Beetle have also changed. For example, the windscreen (windshield) is made of laminated glass whereas it was originally made of toughened glass.

One way that a product may be considered as a design classic is by the length of the maturity phase in the product life cycle.

(a) List **two** disadvantages of using steel for the body of cars. [2]

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(Question 7 continued)

(b) Explain why the Volkswagen (VW) Beetle uses laminated glass for its windscreen. [3]

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(c) Explain **two** ways that Volkswagen (VW) can extend the maturity phase of the product life cycle. [6]

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(Question 7 continued)

(d) Explain how mass production, dominant design **and** cultural status have made the VW Beetle a classic design. [9]