MANUFACTURING ENGINEERING TRIPOS PART II

Wednesday 27 April 2011 9 to 12

PAPER 1

*Answer not more than **four** questions.*

*Answer **each** question in a separate booklet.*

All questions carry the same number of marks.

*The **approximate** number of marks allocated to each part of a question is indicated in the right margin.*

There are no attachments.

STATIONERY REQUIREMENTS	SPECIAL REQUIREMENTS
8 page answer booklet x 4	Engineering Data Book
Rough work pad	CUED approved calculator allowed

You may not start to read the questions printed on the subsequent pages of this question paper until instructed that you may do so by the Invigilator

1 (a) Describe the essential features of the following four processes for joining sheet materials: polymer-based adhesive bonding; laser welding; electron beam welding; friction stir welding. [30%]

(b) Discuss the factors which would influence the choice of joining process, from the four listed in part (a), for each of the following applications. For each case suggest, with a reasoned explanation, which of the four would be most appropriate.

(i) Joining textile sheets based on polypropylene, in a high volume application;

(ii) Joining a 5 mm thick sheet of 2000 series aluminium to a 5 mm thick sheet of magnesium alloy for aerospace application;

(iii) Making tailored blanks for automotive body shells. [40%]

(c) Define the term *micro-manufacturing*. Describe a process which could be used to make a large number of identical components consisting of stainless steel sheet, 50 μm thick, perforated with a complex pattern of holes 500 μm square. Which, if any, of the processes listed in part (a) might be used to join these components, and why would the other processes be unsuitable? [30%]

2 (a) Outline the processes used to manufacture ceramic and metallic components from powders. Discuss the similarities and differences between the processes for these two classes of materials. What features of the powder route make it attractive for certain types of product, and what are the limitations of this method of manufacture? [30%]

(b) Explain how the properties of conventional powder metallurgy (PM) products differ from products machined from solid bar, and describe two methods by which the properties of a PM component can be improved by additional processing steps. For each method, give an example of a product for which it would be appropriate, and indicate the advantages of this method over machining from solid. [35%]

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(c) Explain why careful control of particle size is particularly important in the processing of ceramics via a powder route. Describe two examples of applications for which the use of ceramic components offers significant advantages over the use of metals. In each case explain why the ceramic component is preferable. What obstacles are there to the wider use of ceramic materials in engineering applications? [35%]

3 (a) Describe the range of configuration options that exists for automating assembly of manufactured products. [50%]

(b) Discuss the factors that you would consider when making a choice of appropriate assembly method, whether manual or automated. [50%]

4 (a) Discuss the features that need to be considered in the design of:

(i) a robot end-effector for handling small sheet metal components;

(ii) an assembly fixture for the automatic assembly and riveting of sheet metal components.

For each outline a possible design solution. [40%]

(b) Discuss the capabilities of a modern programmable logic controller (plc), explaining in detail the features that make it highly suitable for controlling industrial automation. [25%]

(c) Many modern automation control systems are being developed using distributed architectures.

(i) Outline the design features of these architectures, and describe in detail the role of RFID as a key enabling technology for such architectures;

(ii) Discuss the benefits that can be achieved with these architectures. [35%]

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5 (a) Explain why effective asset management is important to organisations in the oil and gas sector. [25%]

(b) Discuss the different factors related to maintenance that should be considered during plant design. [25%]

(c) Discuss the use of a risk assessment matrix in developing an asset maintenance strategy. [25%]

(d) Explain with examples the factors that can be used to differentiate between good and bad maintenance services. [25%]

6 (a) What is an eco-audit? Explain how you would conduct an eco-audit to allow an estimate to be made of the energy payback period of a wind turbine. Discuss the limitations of the eco-audit approach in the wider context of sustainability audits. [60%]

(b) Outline how you would assess the *green credentials* of a factory, using specific examples to illustrate your discussion. [40%]

END OF PAPER