Version RD/5

MET2
MANUFACTURING ENGINEERING TRIPOS PART IIA

Friday 7 May 2021 9.00 to 10.40

Paper 6

MODULE 3P10: CONTEMPORARY ISSUES IN MANUFACTURING

*Answer **all** questions.*

All questions carry the same number of marks.

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

*Write your candidate number **not** your name on the cover sheet and at the top of each answer sheet.*

STATIONERY REQUIREMENTS
Write on single-sided paper.
You may type your answers.

SPECIAL REQUIREMENTS TO BE SUPPLIED FOR THIS EXAM
CUED approved calculator allowed
You are allowed access to the electronic version of the Engineering Data Books

10 minutes reading time is allowed for this paper at the start of the exam.

The time taken for scanning/uploading answers is 15 minutes.

Your script is to be uploaded as a single consolidated pdf containing all answers.

1 A small firm wants to reduce its environmental impact. The firm makes and distributes children's toys, selling directly to consumers. Business aspects of the firm are run from offices within the factory building. The main operations within the factory are polymer injection moulding, sheet metal work (drilling, cutting and bending sheet steel), spray painting of metal parts, manual assembly of products, packing, and dispatching. There are 20 employees on site.

The firm commissioned an initial study to measure environmental impact using the carbon footprint metric of everything that takes place within the factory building. This includes manufacturing and assembly operations and the supporting activities of office-based work. For this initial assessment, any operations taking place outside of the factory (e.g. transport) are excluded. Material flow into or out of the factory is also excluded (goods in and out, and waste streams).

(a) Discuss the validity of using carbon footprint as the only metric of environmental impact, and including only the in-factory operations. In your discussion, suggest additional metrics that the company should consider if it undertakes a more detailed environmental impact analysis at a later date. [50%]

(b) The firm has identified the factors that it expects to contribute most to carbon footprint as:

- operation of manufacturing machinery and equipment;
- operation of office equipment (computers, photocopiers etc.);
- space and water heating;
- lighting.

(i) Rank these four contributing factors by relative importance, including reasons for your assessment. For each factor explain what would contribute to the carbon footprint. [30%]

(ii) Describe ways in which the carbon footprint could be reduced for each of the four factors, indicating the financial implications of the measures you suggest. [20%]

2 (a) A firm is planning to manufacture a new surgical suture, which is considered a medical device. This is a thin polymer thread used to stitch or hold tissue together after surgery. This thread will degrade slowly so no additional surgery is needed to remove it. As it degrades, it will release additional drugs to accelerate healing. A box contains 50 individually wrapped sutures, each of the same standard length.

(i) What are the main considerations when choosing a suitable polymer for this application? What are the advantages to this approach to drug delivery? [20%]

(ii) The finished product needs to be shipped to the customer fully sterilised. Explain what is meant by the term sterilisation, in the context of medical device manufacturing. [10%]

(iii) Describe a suitable technique that may be considered to carry out sterilisation and explain your reasoning. How would you check if the chosen process is suitable? [30%]

(iv) The firm trialled your suggested sterilisation technique and recorded the number of micro-organisms present on the medical devices after exposure to the sterilisation environment for 20 seconds, 30 seconds and 40 seconds. Describe a method to calculate the bioburden of the devices and the time required to complete sterilisation. [20%]

(v) A new production tool could produce a thinner thread and make it 10 times faster. This will reduce manufacturing costs and the firm is considering investing in the tool. Describe any *three* costs, other than the purchase of the tool, that may be incurred by the firm if they move to the new production tool. [20%]

3 (a) (i) Describe the *phase-gate* process (also known as the *stage-gate* process). [30%]

(ii) Why would a firm use the phase-gate process when aiming to translate an innovation into a market? [20%]

(iii) There are challenges to adopting the phase-gate process to manage high-risk emerging technology innovations. Describe one additional management tool that may help in such cases. [20%]

(b) (i) Explain why governments promote research in generic technologies and infra-technologies. [20%]

(ii) There are many examples of frameworks developed to help manage the translation of an innovation into a market. Explain the benefits of developing a customised framework. [10%]

END OF PAPER