Version TM/4

MET 3

MANUFACTURING ENGINEERING TRIPOS PART IIB

Wednesday 24 April 2024 9.00 to 12:10

Paper 2

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

Answer each question in a separate booklet.

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 of each booklet.

STATIONERY REQUIREMENTS

8 page answer booklet x 4

Rough work pad

SPECIAL REQUIREMENTS TO BE SUPPLIED FOR THIS EXAM

CUED approved calculator allowed

Engineering data books

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

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

You may not remove any stationery from the Examination Room.

Question 1

(a) Explain the similarities and differences between management and leadership. Use examples from theory and practice to support your answer.

[30%]

(b) Two organisations are facing significant challenges to their operations. The first is a large automotive manufacturing firm that is attempting to transform its operations from producing internal combustion-powered vehicles to battery-powered vehicles. The second is the UK's National Health Service (NHS) that is struggling to deliver effective services and is seeking to adopt digital technologies to integrate activities and improve efficiency.

(i) Discuss and contrast the people management challenges that the senior management teams in the two organisations are likely to encounter when implementing these changes; and

(ii) For both organisations, discuss approaches to address these challenges, providing examples to support your answer.

[70%]

Question 2

(a) Compare and contrast how the *Market-Based Approach* to strategy making and the *Resource or Capability-Based Approach* are used in developing a sustainable competitive advantage for industrial businesses. Discuss why companies might prefer to adopt one approach over the other.

[40%]

(b) GenCo is a large, multinational manufacturing business whose main product is large gas-turbine systems for various markets. The company designs, manufactures and sells products and industrial services related to these gas-turbine systems. It focuses on delivering industry-leading products and services to customers and achieving profitable growth for its shareholders. Power systems for civil aviation represent the company's main area of growth.

Over the past ten years, GenCo has invested £11 billion in R&D and production facilities, and has launched six new types of gas turbine engines for the civil aviation market. The company secured orders for over 2,000 engines and expects to sustain the production of 600 engines a year.

(i) In this context, explain and illustrate with examples what *operations strategy* is, and its associated *decision areas*.

[30%]

(ii) Describe and illustrate with examples five *operations performance objectives* for GenCo's civil aviation business.

[30%]

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Question 3

You work as Head of Innovation and Technology Management for UK-based, medium-sized manufacturing company that operates internationally. The company has been operating for a while and competition in the market is increasing. Your CEO has put you in charge of a product line that your company manufactures in-house. Due to competitive pressure, the product line is only marginally profitable. You have been given targets to improve profitability.

(a) To identify options for short-term profitability improvements, you have tasked your R&D team to investigate the product architecture and manufacturing process. Your team came back with the following three suggestions.

- The product architecture can be optimized by replacing metal in some components with cheaper materials, e.g. composites. This requires little development effort and can lower the product weight by 3%, resulting in a 5% longer battery life during its use-phase for your customers.
- Your team can modify some of the tools used by the assembly robots for this specific product line in an innovative way that would reduce production time by 5%, which will reduce per-unit production costs, thus boosting profitability.
- An innovative technical feature can be added to the product so that it will be more distinct from competitor products. While the costs for developing this feature would be moderate, it can increase profitability by 3%. This feature has the potential to be added to other product lines.

What type of technology protection (patent, trade secret, defensive publishing) do you recommend for each of the three suggestions above? Justify your answers.

[25%]

(cont.

(b) In order to further boost profitability, you decide to acquire technology and additional ideas from outside your own firm. You are contemplating the following three options:

- Launching a competition (e.g. joining a crowdsourcing platform) inviting others to suggest ideas to further improve your products.
- Opening an R&D lab in an overseas high-tech cluster.
- Hiring leading product engineers from competitors.

Explain the advantages and disadvantages of each option using examples.

[25%]

(c) After running your external technology acquisition initiatives for several months, your team identified two suitable technologies that your company could acquire. While both promise improved profitability, your budget allows you to only acquire one of them. Having presented both technologies to your CEO, she advised that any newly acquired technology will need to contribute particularly to the company's sustainable competitive advantage, and increased profitability, while also needing to fit with the company's strategy and be supported by your engineers.

Your assistants have completed an assessment of both technologies resulting in the following tables: 'Feasibility' (Table 1) and 'Opportunity' (Table 2). They used a 10-point scale from 0 being low/small/unimportant to 10 being high/large/highly important.

Evaluate both technologies and reflect on the process you followed to make a recommendation for which technology your company should acquire.

[50%]

(cont.

Factor	Technology 1	Technology 2
Ease of technical implementation	3	7
Organisational backing	6	3
Fit to manufacturing and/or supply chain	2	7
Strategic fit	4	8
Financial investment need	5	4

Table 1

Factor	Technology 1	Technology 2
Increasing our sales potential/market growth	6	1
Increase profit margin	8	4
Potential to differentiate product from competition	7	6
Creating company's sustainable competitive advantage	4	3
Contribution to positive brand image	4	8
Supporting customer relations/loyalty	3	5

Table 2

Question 4

As a manager in a UK manufacturing firm, you are tasked with analysing and potentially redesigning your company's supply chain to enhance its resilience against climate change.

(a) Identify specific vulnerabilities the company may face related to climate change. Provide examples to support your answer.

[30%]

(b) Outline the key considerations involved, and the steps you would take to redesign the supply chain.

[40%]

(c) Explain how these changes would address the vulnerabilities identified in your answer to part (a).

[30%]

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Question 5

Tecida, a small metal-product manufacturer, makes two types of turbine blade at one of its production sites. These blades are used in two different sizes of microgenerators, used for generating electricity from small hydroelectric plants. The smaller product is known as Blade A and the larger as Blade B.

The blades are stamped out of two grades of sheet metal. Blade A uses a low-grade recycled steel with a high impurity content (chiefly copper). Blade B uses high-grade steel with low impurity content. The process leaves behind a 'skeleton' of unused sheet metal. Blade A tessellates onto the sheet such that a typical skeleton consists of 20% of the sheet. Blade B tessellates slightly better, leaving only 15% as 'skeleton waste'. About 1% of each type of blade is rejected for being of incorrect quality. The skeleton waste from both lines and the rejected blades are collected in a single bin and sold to a recycler.

Key statistics for Tecida are summarised in Table 3.

(a) (i) *Zero Loss Yield* has been proposed as a suitable metric to analyse the *material utilisation efficiency* of the Tecida products. Define *Zero Loss Yield* and explain what this analysis should achieve. What data is required, and how can it be obtained?

[25%]

(ii) Use *Zero Loss Yield* analysis to estimate the *material utilisation efficiency* for each of Tecida's products. Identify and comment on the main sources of potential material loss, stating any assumptions you make. What additional information would be required to refine your analysis?

[50%]

(cont.

(iii) How does your *Zero Loss Yield* analysis relate to a single-figure metric for assessing the overall production efficiency of turbine blades within Tecida? What might be the benefits of having a single-figure metric for efficiency? What additional information would be required to enable such analysis?

[5%]

Statistic	Value	Unit
Start of Year Material Stock (Low Grade Steel for Blade A)	2,000	Sheets
Start of Year Material Stock (High Grade Steel for Blade B)	500	Sheets
End of Year Material Stock (Low Grade Steel)	200	Sheets
End of Year Material Stock (High Grade Steel)	1,000	Sheets
Low Grade Steel Purchased (Sheets)	10,000	Sheets
High Grade Steel Purchased (Sheets)	8,000	Sheets
Mass per sheet (Low Grade Steel)	5.75	kg
Mass per sheet (High Grade Steel)	4.25	kg
Design Mass (Blade A)	0.30	kg
Design Mass (Blade B)	0.50	kg
Sales (Blade A)	150,200	Blades
Sales (Blade B)	50,100	Blades
Rejection rate (Blade A)	1%	
Rejection rate (Blade B)	1%	
Start of Year product stock (Blade A)	4,000	Blades
Start of Year product stock (Blade B)	2,000	Blades
End of Year product stock (Blade A)	1,000	Blades
End of Year product stock (Blade B)	6,000	Blades
Mass of Steel Recycled	12,000	kg

Table 3

(cont.

(b) Using the concept of *Value Uncaptured*, discuss the advantages and limitations of the two following proposals for sustainability improvement.

- The single recycling stream is separated into two streams, one for each grade of steel.

[10%]

- A proposed new design for Blade B reduces its overall mass to 0.4kg, improving the efficiency of the microgeneration turbine. However, the new design does not tesselate as well, increasing the skeleton waste to 32% of the sheet.

[10%]

Question 6

(a) Explain what is meant by a *logic model* in the context of policymaking. Use examples to support your answer.

[15%]

(b) The UK government wants to encourage smaller manufacturing firms to adopt technologies likely to reduce their climate impact. Describe how *technology management tools* could be used to identify and select which technologies the government should be encouraging such firms to use.

[40%]

(c) Discuss how a *logic model* could be used effectively to support the planning and implementation of a policy programme for the diffusion and deployment of the technologies identified from the use of tools described in part (b).

[45%]

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