Version JMC/4

EGT2
ENGINEERING TRIPOS PART IIA
EGT3
ENGINEERING TRIPOS PART IIB

Friday 9 May 2025 9:30 to 11.10

Module 4C4

DESIGN METHODS

*Answer not more than **three** 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.*

STATIONERY REQUIREMENTS
Single-sided script paper

SPECIAL REQUIREMENTS TO BE SUPPLIED FOR THIS EXAM
CUED approved calculator allowed
Engineering Data Book

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.

1 A company claims it has produced a more sustainable bio-based plastic, which is made from a straw based bio-feedstock material. The plastic has been tested as a replacement for high-density polyethylene (HDPE), which is commonly used in water and sewage piping systems.

(a) State the United Nations Brundtland Commission definition of sustainability. [10%]

(b) Describe briefly what it means to take a *whole systems approach* and how this improves sustainability. Relate your answer to the specific example of the bio-based plastic. [20%]

(c) List six principles for sustainable system thinking, and describe how each principle might be used to validate the sustainability claims of the company. [50%]

(d) Describe three ways which the company might obscure the real impacts, or *green-wash* the results, to make the bio-based plastic appear more sustainable for commercial gain. [20%]

2 A manufacturing firm is making front doors. They have a new front door product that promises higher insulation and a lower price than their previous front door product.

(a) Explain what is meant by the term *product life cycle* in the design process and describe its four phases. [20%]

(b) Give four reasons why the firm may feel it is necessary to offer the new front door product. [20%]

(c) Following market research, the firm is considering offering a front door product with an integrated smart camera that can record and react to events outside the front door.

(i) Provide a function structure diagram that indicates the key functions of this front door product. [20%]

(ii) Propose and motivate a product architecture for this front door product, and describe its key modules. [20%]

(iii) Explain why, and how, the product architecture is likely to evolve over time. [20%]

3 The transition to a zero-carbon world will require moving away from fossil fuel extraction and combustion, towards more complex and material intensive technologies which extract energy from nature. These technologies, including solar panels, wind turbines and batteries, require greater quantities and more complex combinations of materials, with potential impacts on our ability to secure supplies of critical minerals used in their production.

(a) Define *risk management* and list four strategies for managing risk. [20%]

(b) Identify ten risks present in the supply chain of critical minerals. [10%]

(c) Define suitable descriptive scales for measuring the likelihood and the impact of the risks identified in part (b), using a scoring system from 1 (low) to 5 (high). Score each risk and create a ranked list of the ten risks. [30%]

(d) Suggest actions for mitigating the risk for the top five risks from your ranking in part (c). Rescore these five risks assuming that the suggested actions have been taken. Plot the pre-mitigation and post-mitigation scores for the five risks on a risk matrix. [30%]

(e) Discuss briefly how risks are borne by different actors along the supply chain for critical minerals, providing two examples. [10%]

4 A company is designing a new tractor for agricultural use. The tractor uses an online weather data service, an online database on crop, soil, and crop yield, and integrated sensors in the tractor itself, to provide the driver with real-time information on crop yield as the tractor moves around in the field. This allows the driver to adjust routes, learn about the soil characteristics, and vary the application of fertiliser and chemicals in real-time.

(a) Derive a solution-neutral problem statement for this task. [10%]

(b) Propose a system boundary. Explain your reasoning. [20%]

(c) Explain why this system is complex and suggest a strategy for describing the system using a diagram. [30%]

(d) Propose four key requirements of this design and explain how each requirement can be verified. [20%]

(e) Describe a strategy for validating the system. [20%]

END OF PAPER

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