Version EP/4

EGT2
ENGINEERING TRIPOS PART IIA
EGT3
ENGINEERING TRIPOS PART IIB

Friday 1 May 2026 14.00 to 15.40

Module 4M21

SOFTWARE ENGINEERING AND DESIGN

*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 You work for a company that is developing an AI-enabled pen. The pen has a single button that users can press and then speak with an intelligent chatbot. The chatbot's responses are synthesised as speech and played through a small speaker on the pen. The pen also has a camera so that the user can include images in the chat and ask questions about those images. To take a photo with the camera, the user must long press on the pen's button. A distinct beep confirms the two different types of button press: short press and long press.

(a) The product team wants to estimate whether the pen is more efficient than using a smartphone to ask a simple query about an image. Use a Keystroke-Level Model GOMS (KLM-GOMS) analysis to estimate the time it will take an expert user to take a photo, ask a query and get a response using both devices. For the smartphone, you can assume that it is unlocked, but that the user must find and open their preferred chatbot application. The user will then use the in-app functions to add an image to the chat by taking a photo, and the in-app function to ask a query using voice input. For the pen, you can assume that the user must first take a photo by using the long press on the button, and then ask their question after a short press on the button. Propose the operators required for the analysis and estimate their durations. [40%]

(b) Explain the limitations of your KLM-GOMS analysis. [10%]

(c) The product team appreciates your KLM-GOMS analysis but wants some more evidence of the time saving to support their marketing claims. You suggest running an experiment. Explain the difference between a within-subjects design and a between-subjects design. [10%]

(d) Briefly describe and motivate an experimental design for a study comparing the efficiency of each device in the task of answering a question about a physical object in the user's vicinity. [20%]

(e) After running an experiment with one participant, they casually mention to you that they would be reluctant to use the pen in public due to the need to speak out loud. You suggest to the product team that further user research is required. Propose and motivate an alternative research method you could use to uncover when and how people will actually use the pen in practice. [20%]

2 You are developing a virtual reality-based application for monitoring multiple security camera feeds. The application includes an anomaly detection function that triggers when something atypical has been observed in a given camera feed. When the anomaly detection function triggers, the user receives a visual and audio alert and the camera feed that triggered the alert is enlarged and moved to the centre of the user's field of view.

(a) Explain how this system can be evaluated against the user-centric and system-centric evaluation criteria in the types and levels of automation framework. [30%]

(b) When the anomaly detection function triggers, a small dialog box is also displayed to the user. This dialog has two buttons: 'Dismiss' and 'Raise Alarm'. Explain the difference between *mistakes* and *slips* in the context of the user interacting with this dialog. [10%]

(c) Assume that under normal operation, the camera feeds are arrayed in a grid in front of the user. To centre and enlarge a camera feed, the user must move their hand and touch on the desired camera feed. Which law could be used to model the movement time involved in performing such a selection, and what are the two main geometric attributes of the interface that influence user performance? [15%]

(d) Explain how the Windows of Visibility concept can inform the visual design of the interface. [15%]

(e) How might we obtain a better understanding of the visual saliency of the interface features and a user's attentional strategy? [10%]

(f) Propose a method for assessing the key risks in this system. Motivate your answer. [20%]

3 A university system records students' grades using a class called *GradeProcessor*, which provides a single method, `recordGrade`, for recording a student's grade in a given module. *GradeProcessor* has two attributes, `doPortalUpdate` and `doAnalyticsUpdate`, each indicating whether a corresponding action should be performed by the *StudentPortal* class (to update what the student sees when they login) and the *GradeAnalytics* class (to update displayed summary statistics).

(a) Draw a UML class diagram for the *GradeProcessor* class. [10%]

(b) Discuss advantages and limitations of the current design. [20%]

(c) Some students have requested to receive an email alert when a grade is published, and the *EmailNotifier* class is used to provide this additional action. Refactor the design using an appropriate design pattern to support the easy addition of new actions, such as email notifications, when a grade is recorded.

(i) Draw a class diagram to illustrate your proposed enhanced software design. [40%]

(ii) Draw a sequence diagram that shows a grade being recorded, an email notification sent to the student and the summary statistics updated. [20%]

(iii) Explain which of the limitations identified in part (b) are addressed by the proposed enhanced design. [10%]

4 A logistics company plans to develop a shipment tracking system that will be used by customers, delivery drivers and operations managers to track shipments in real time and to analyse logistics performance.

(a) Identify and describe three functional requirements and three non-functional requirements for the system. [20%]

(b) The company has decided to adopt Scrum for this project.

(i) Identify and explain the Scrum roles in the context of this project. [15%]

(ii) Justify the decision to use this framework instead of a more traditional approach. [15%]

(c) Explain how user stories can capture functional requirements. Provide three user story examples relevant to this project. [15%]

(d) Explain how user stories support the testing process. [15%]

(e) Non-functional requirements can be more difficult to test than functional requirements. Discuss the challenges of testing non-functional requirements identified in part (a) and explain how these challenges can be addressed. [20%]

END OF PAPER

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