Version JMC/8

EGT2
ENGINEERING TRIPOS PART IIA
EGT3
ENGINEERING TRIPOS PART IIB

Monday 4 May 2015 9.30 to 11

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.

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

1 An engineer is planning the layout of a new car park for a local store. The customers: (1) have cars of width w, typically in the range 1.75m to 1.95m; (2) drive forward into the parking bay leaving a parking tolerance a of 0.1m to 0.7m from the left-hand side of the parking bay; and (3) exit from the right-hand side of the car, requiring an exit tolerance b of 0.7m to 0.9m to comfortably open the door.

Assume that the car width w, parking tolerance a and exit tolerance b vary independently as normal distributions, with standard deviations defined as half of the range quoted above, i.e. standard deviation = (maximum – minimum)/2.

(a) Assume that the car park comprises only single bays of width w_1, as shown in Fig. 1(a).

(i) The engineer takes as an initial design that w_1 equals 3.2m. Assuming that the customer parks their car with reference to the left-hand side of the bay, as described in (2) above, estimate the proportion of customers that will be unable to exit their cars comfortably. [20%]

(ii) Calculate the minimum single bay width w_1, to the nearest 0.1m, that would allow at least 95% of customers to exit comfortably from their cars. [20%]

(b) In an alternative design, the engineer proposes double bays, as shown in Fig. 1(b). Drivers are instructed to park first in the right-hand bay, which is of width w_1 as calculated in (a) part (ii). For both bays the customer parks their car with reference to the left-hand side of the bay, as described in (2) above.

(i) The left-hand bay is of width w_2 equal to 3.2m. What proportion of drivers parking in this bay will be able to exit their cars comfortably? [20%]

(ii) The engineer redesigns the left-hand bay to a width w_2 that will allow 95% of drivers to exit their car comfortably from this bay. Calculate w_2 to the nearest 0.1m. [20%]

(c) Discuss how the above approach can be utilised for multi-bay car park design. [20%]

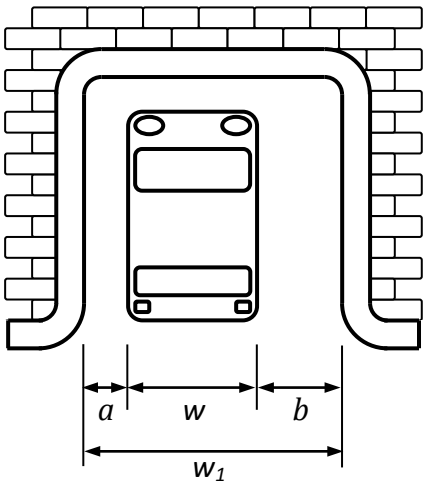

Fig. 1(a)

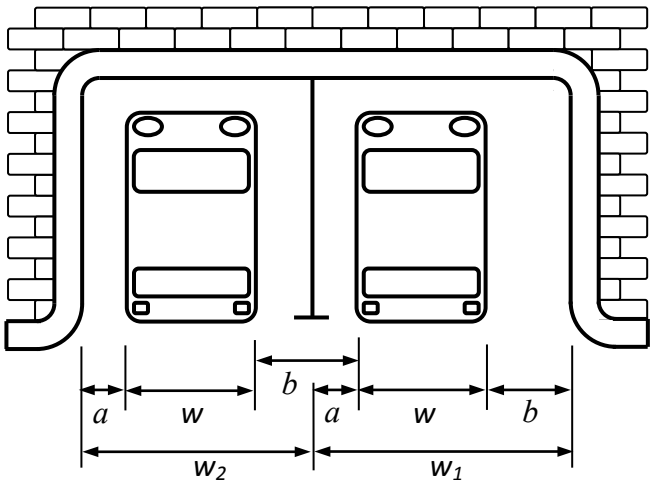

Fig. 1(b)

2 Mobile phones typically have a locking feature that prevents unauthorized access by automatically locking the device when the mobile phone is unused for a set amount of time. To regain access the user must use an unlocking method, such as entering a PIN code or touching a finger print reader. A particular mobile phone manufacturer has decided to supply their mobile phones with an unlocking method that can be used by people with severe hand tremor, such that they are unable to reliably input PIN codes or use a finger print reader.

(a) Use a solution-neutral statement to describe the overall function of the new unlocking method. [10%]

(b) List the key requirements for the new unlocking method. [20%]

(c) Define a process function structure for the new unlocking method. [20%]

(d) Identify solution principles for the functions identified in (c), and describe an unlocking method that will both prevent unauthorized access and allow people with severe hand tremor to use it reliably. [50%]

3 (a) Draw a dependency structure matrix for the process depicted in Fig. 2 with the rows and columns A through E in order. [20%]

(b) Show how all feedback marks in the dependency structure matrix drawn in (a) can be systematically eliminated by partitioning the dependency structure matrix. [30%]

(c) It is discovered from further study of the dependency structure matrix in (b), that in addition, task A depends on task B. Discuss how integration and decomposition strategies can alternatively be used to manage this new situation. [30%]

(d) Explain what a multiple domain matrix is and give an example of a system structure that can be analysed with this technique. [20%]

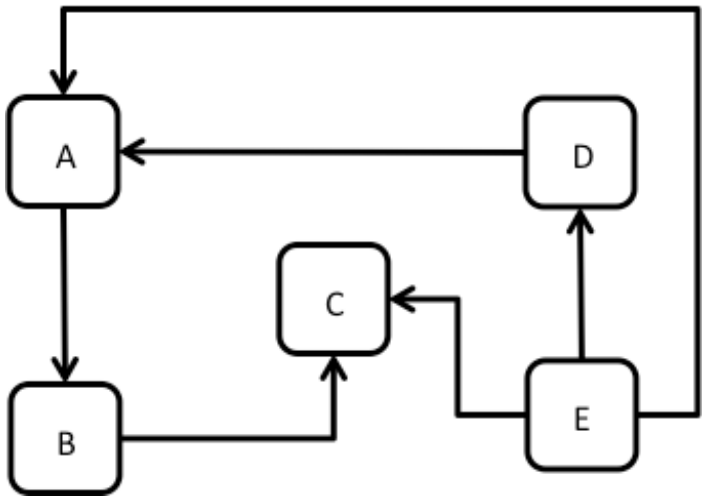

Fig. 2

4 The UK Government wishes to develop a new electronic voting system that will enable citizens to register their vote in the UK Parliamentary elections using any internet connected device. A particular company has been asked to develop the new voting system to be trialled in the Cambridge constituency in the upcoming elections.

(a) Describe the elements of good risk management practice that enable the successful delivery of a new system to market. [40%]

(b) List the key elements required for the online voting system. [15%]

(c) Sketch a fault tree highlighting events that may lead to the unsuccessful operation of the new voting system. [25%]

(d) Describe possible verification and validation approaches to support the timely delivery of the new online voting system. [20%]

END OF PAPER

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