Version RET/4

EGT2
ENGINEERING TRIPOS PART IIA

Wednesday 20th April 2016 2 to 3.30

Module 3F6

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.

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

1 (a) Describe the principles and benefits of the *Decorator Design Pattern*. [20%]

(b) A smartphone application allows users to automatically translate text on foreign-language road signs by pointing the camera at the sign and showing the translation in real-time on the same screen.

The application is designed to utilise the `CameraView` class that can display a direct image stream from the `Camera` class and draw the translation on top of it. The `Camera` class can also provide a snapshot image that can be analysed by the class `Translator`. The `Translator` can find text in the image and translate it from one language to another.

In the current design, the application periodically requests image snapshots from the `Camera` class and passes them to the `Translator` class for analysis. Using the *Observer Design Pattern* the `Translator` class notifies the `CameraView` of whether or not the foreign text that needs to be translated is found in the snapshot. If there is no text found to translate, the previous translation should be cleared.

(i) Draw a *Class Diagram* of the system described, showing the classes and their associations. [40%]

(ii) Draw a *Sequence diagram* of the system described, showing the scenario when the foreign text is found in the image. [40%]

2 (a) In *User Interface* (UI) design, explain the main ideas behind *Activity Based Planning* and describe what a *Use Case* is. [15%]

(b) A company is working on a news aggregator application that allows users to have immediate access to breaking news, quickly skim the main headlines and read full news stories.

(i) Design the UI for a software application for a smartphone that implements this functionality. Identify all of the main screens and interaction elements in your design, explain their purpose and design constraints. [25%]

(ii) A popular feature request was to extend the application functionality to allow the users to select their favourite topics and publishers, access their local news and save and share their favourite articles. Extend the UI to enable this feature in the application. [40%]

(iii) The team identified a large percentage of tablet users among those downloading the application. Optimise the design of the personalised news aggregator application to improve the user experience on tablet devices. [20%]

3 A company has designed a database to store information about academic papers. A simple version of the database is shown in Fig. 1. Each column contains all the information for one paper indicated by its title (Title). For each paper a record is kept of the date of publication (Year), the authors, the affiliations each author has (which can be assumed to be fixed through time), and the titles of the papers cited.

The full database will contain thousands of papers and each paper can have many authors and cite many other papers.

Title	Principia	Special Relativity	General Relativity	Quantum Field Theory
Year	1687	1905	1916	1925
Author 1	Newton	Einstein	Einstein	Dirac
Affiliations	Cambridge	Zurich, Caltech	Zurich, Caltech	Cambridge
Author 2				Fermi
Affiliations				Columbia, Chicago
Citation 1		Principia	Principia	Special Relativity
Citation 2			Special Relativity	General Relativity

Fig. 1

(a) Evaluate the database design and suggest how to improve it. Draw an *Entity-Relationship Diagram* to illustrate your answer. [20%]

(b) Show the updated design of the tables including any new *Entities* and *Attributes* added in the answer to part (a). Identify the *Primary* and *Foreign keys* used. [15%]

(c) Design a query to return the titles of all the papers that Dirac has authored. Express your answer using relational algebra or SQL code and explain your solution. [20%]

(d) Design a query to return the titles of all the papers cited by papers cited by Dirac. Express your answer using relational algebra or SQL code and explain your solution. [35%]

(e) The company wants to make many queries similar to the one in part (d). Describe features that could be added to the database to accelerate such queries and detail any potential disadvantages they may have. [10%]

4 (a) State the four ACID properties of transactions and explain why each is important. [20%]

(b) Fig. 2 shows a sequence of twenty actions scheduled for execution by four transactions T1, T2, T3 and T4 operating on five database accounts A, B, C, D and E. A concurrency control protocol is used in which each operation `Q.read` must acquire a read lock Q.R on account Q and each operation `Q.write` must acquire a write lock Q.W on account Q. Once acquired, all locks are held until the transaction commits or aborts.

action number	transaction	action		action number	transaction	action
1	T1	`A.read`		11	T2	`C.read`
2	T1	`B.read`		12	T2	`C.write`
3	T1	`A.write`		13	T4	`C.write`
4	T2	`B.read`		14	T3	`A.read`
5	T3	`C.read`		15	T3	`C.write`
6	T1	`B.write`		16	T1	`commit`
7	T1	`E.write`		17	T2	`D.write`
8	T4	`B.read`		18	T2	`commit`
9	T2	`E.write`		19	T3	`commit`
10	T2	`D.read`		20	T4	`commit`

Fig. 2

(i) Draw a *resource allocation graph* for this sequence of transactions and hence determine the first point at which deadlock occurs. [40%]

(ii) Draw the corresponding *wait-for-graph* at deadlock. [20%]

(c) Explain how a system can recover from deadlock and discuss the criteria for choosing a *victim*. What would be the best choice of victim in this case and in what order would the remaining transactions then complete? [20%]

END OF PAPER

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