

UNIVERSITY OF LONDON
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2003

BEng Honours Degree in Computing Part III
BEng Honours Degree in Information Systems Engineering Part III
MEng Honours Degree in Information Systems Engineering Part III
BSc Honours Degree in Mathematics and Computer Science Part III
MSci Honours Degree in Mathematics and Computer Science Part III
for Internal Students of the Imperial College of Science, Technology and Medicine

*This paper is also taken for the relevant examinations for the
Associateship of the City and Guilds of London Institute
This paper is also taken for the relevant examinations for the
Associateship of the Royal College of Science*

PAPER C302=I3.8

SOFTWARE ENGINEERING - METHODS

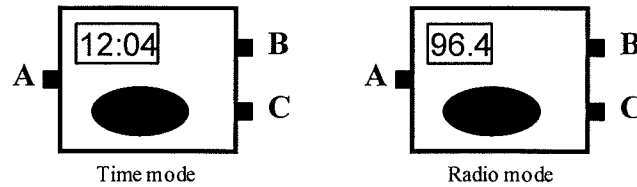
Monday 28 April 2003, 14:00
Duration: 120 minutes

Answer THREE questions

Paper contains 4 questions
Calculators required

Part A – please answer in separate answer booklet

- 1a Name and briefly define the four main elements of a Design Pattern description.
- b A miniature digital radio has three buttons as shown below:-



The radio has three modes that are cycled through by pressing button A:

- *Time* is the initial mode in which it displays the time of day, buttons B and C have no effect in this mode,
- *Setting* mode in which button B increments hours and button C the minutes,
- *Radio* mode in which button B increments the frequency (tune up) and button C decrements the frequency (tune down).

You are given the following interfaces:

```
interface Setting {  
    void incrementMinutes();  
    void incrementHours();  
}  
  
interface Radio {  
    void tuneUp();  
    void tuneDown();  
}
```

Assume the following static methods are available to get objects that implement these interfaces:-

```
class DigitalRadio {  
    public static Setting getSetting();  
    public static Radio getRadio();  
}
```

You are required to design an implement a set of classes that *flexibly* implements the following interface:

```
interface RadioControl {  
    void buttonA();  
    void buttonB();  
    void buttonC();  
}
```

Your answer should include a class diagram and the Java definition/ implementation of any interfaces and classes that you use in the design. (You do not have to implement Setting or Radio). Identify any design patterns that you use.

- c Briefly describe how your design can be extended to incorporate a new mode *Alarm* that permits an alarm time to be set.

The three parts carry, respectively, 10%, 75%, 15% of the marks.

- 2a Gamma, Helm, Johnson and Vlissides (the Gang of Four) divide Design Patterns into three different categories. Name these three categories and give a brief description (single sentence) of each category.
- b A English to French translation application uses one or more translation dictionaries when performing a translation. There is a standard dictionary that is always present, and there can be additional dictionaries that add technical terms and user defined translations. Complete the translate dictionary class below (replace ... with your code) such that (ignoring creation) the translation application program is independent of the dictionaries that are used for translation. State clearly the Design Pattern(s) used.

```
public abstract class TranslatedDictionary {
    ...
    /* returns French word if English word found otherwise null */
    public String lookup(String word) { ... }

    /* returns French word if English word in this Dictionary otherwise null */
    abstract protected String thisLookup (String word);
}
```

- c A chemical plant process control system encapsulates the value measured by each sensor in a separate object - for example current reactor temperature and pressure values would be encapsulated in two objects. For different purposes and at different times, other components of the process control system need to monitor the values of different sets of sensors. Suggest a design pattern that could be used to structure this part of the software and draw a UML class diagram illustrating its use.
- d Suggest a Design Pattern(s) that can be used to solve each of the following problems, explaining very briefly why it is applicable:
- i) The interface to an object is different to that expected by a client.
 - ii) Need a single interface to a set of functionally related objects.
 - iii) An undo facility is required for a graphics editor.
 - iv) Need to sequentially access the contents of a collection of elements without revealing the structure.
 - v) Need to add additional functionality to some instance of a class but not to all of them.

The four parts carry, respectively, 15%, 35%, 25%, 25% of the marks.

Part B – please answer in separate answer booklet

3 *Ethical conflicts, accountability, and responsibility*

Study the following scenario:

Civil engineers employed by a government agency of the United Kingdom were engaged in numerous construction design projects, such as flood control, where safety of humans is a factor. They were held personally responsible for their work, under a professional and business responsibility law. In their design activities, the engineers increasingly relied on computer programs designed by systems analysts and implemented by computer programmers. The engineers specified the problems requiring solutions and, to various degrees, specified the methods of solution and test cases for demonstrating that the computer programs functioned correctly. Several of the computer programs included logic where decisions were based on engineering-specified criteria and where the program output selected types and quantities of construction materials and stated how deliverable end products were to be constructed.

The engineers complained to their management that they were not able to determine the correctness and integrity of the computer programs, and the results of their work relied heavily on those qualities. Therefore, an error in a computer program or an error in operation of the computer (that could be detected by the programmer) could result in a serious design flaw that could cause harm to people. The engineers wanted the system analysts and computer programmers to share the responsibility for any losses under the professional and business law.

The system analysts and programmers stated that they were merely providing tools and had no involvement in their use. The engineers could test and analyze the programs to ensure themselves of their accuracy. Therefore, the system analysts and programmers should not be held responsible.

[adapted from Donn B. Parker, Susan Swope, and Bruce N. Baker: *Ethical Conflicts in Information and Computer Science, Technology, and Business*; Wellesley, Massachusetts, QED Information Sciences 1990]

-
- a Identify five key stake-holders in the scenario given above. List each stake-holder's risks and benefits at issue.
 - b Using the above scenario as a context, provide a short commentary on the statement : "A licensed engineer who is not liable for a professional action is also not morally accountable for such an action."
 - c The so-called *problem of bugs* may be stated as "Even with proper professional standards being adhered to, software bugs will always occur in real systems." Explain the relevance of this problem in the above scenario.
 - d Analyze the above scenario with respect to who, and to which degree, is morally responsible or legally liable if flawed software or un-anticipated context of its use were to bring about constructions that cause physical or monetary harm. (Please ensure that your analysis is well structured and that your findings are sufficiently justified.)

The four parts carry, respectively, 20%, 20%, 20%, and 40% of the marks.

4 Ethical reasoning

Study the following excerpt from the Chicago Tribune, March 18, 2002, online edition (needed for parts a **and** b):

“It’s an all too familiar happening---the phone rings, and when you pick it up, nobody’s there. Time was when such calls probably were wrong numbers, or teenagers amusing themselves, but these days it’s more likely a ploy by the billion-dollar telemarketing industry. The marketers have computers do their dialing to set up calls that are routed to a marketer as he becomes free. If no one is free when you pick up, the computer hangs up. That improves productivity for the marketing firm, even if it is annoying to people getting the calls.

Now there’s a new twist. The marketing computer always hangs up. The goal is to leave a message on your Caller ID system that will induce you to call back and get a prerecorded pitch. This new approach lets marketers automate their operations, saving payroll expenses and drastically cutting the marketer’s phone bill.”

- a Consider a marketing company that operates according to the approach described in the first paragraph of the excerpt above. Give a clear justification of your answers to the following:
 - i) Use the framework of Utilitarianism to analyse whether, or to which extent, the company’s marketing practice is ethical.
 - ii) Use the framework of Kant’s theory of intrinsic values, notably his **categorical** imperative, to analyse whether, or possibly to which extent, the company’s marketing practice is ethical.
- b Consider a marketing company that operates according to the **new** approach described in the last paragraph of the excerpt above. Give a clear justification of your answers to the following:
 - i) According to **your own analysis**, is the operation of this new approach ethical? Argue your case in detail, making all methodological or scenario-specific assumptions explicit.
 - ii) Use the framework of Kant’s theory of intrinsic values, notably his **practical** imperative, to analyse whether, or possibly to which extent, the company’s marketing practice is ethical.

The two parts carry, respectively, 50% (25% each), and 50% (25% each) of the marks.