UNIVERSITY OF EDINBURGH

FACULTY OF SCIENCE AND ENGINEERING

COMPUTER SCIENCE THREE

SOFTWARE ENGINEERING WITH OBJECTS AND COMPONENTS 1

Wednesday 11 September 2002

09:30 to 11:00

Examiners:

Prof. K. Turner (External)

Prof. C. Stirling (Chairman)

INSTRUCTIONS TO CANDIDATES

Answer any TWO questions.

All questions carry equal weight.

IMPORTANT: READ THE FOLLOWING TEXT BEFORE ATTEMPTING ANY QUESTIONS

All questions in this paper concern the development of a software control and accounting system for the Val D'Aree ski resort. The resort is based around the village of Aree, above which is a network of ski-slopes connected by a variety of lifts, and a small number of mountain-side restaurants. The skier's use of lifts is organised around the lift-passes, which each skier must purchase. The management of Val D'Aree plan to upgrade the entire lift-pass system, replacing the existing paper lift-passes with "smart" electronic passes and automatic pass-readers at each lift. The software system to support this upgrade, known as "SLIP" (Ski-Lift Integrated Passes), will also support the monitoring and auditing of the entire ski-lift network.

1. *Note: ensure that you have read the introductory text on page 1 of this paper before attempting any questions.*

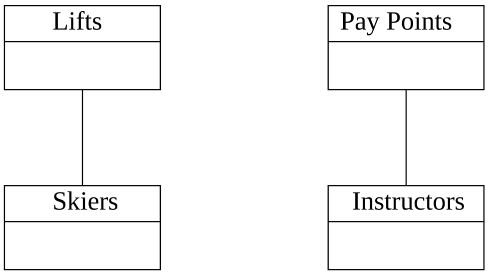
   (a) List any four properties you would expect of a "good" software system. [*4 marks*]

   (b) Val D'Aree occasionally suffers from sudden storms and consequently has a formal procedure for the emergency closing of the ski-slopes, which SLIP must support. Consider the following description of this procedure:

   > The emergency closure of the ski-slopes commences when the resort Safety Manager formally initiates the "Bad Weather Shutdown" procedure. The safety manager informs the Senior Lift Controller to enter phase one of the shutdown. For this, the lift controller informs the individual lift operators and causes a message to be broadcast across the slopes informing the skiers to return to the resort with all haste. While the skiers start skiing down to the resort, the individual lift operators perform a disciplined shut down of their lifts. This involves first preventing any new skiers from joining the lift, and second – once the skiers currently on the lift have exited it – stopping the lift. The operators inform the lift controller once their lifts have stopped and all skiers have left their vicinity. The lift controller informs the safety manager that phase one is complete, who records this fact, and instructs the individual lift operators to initiate phase two. In phase two the lift operators themselves ski down to the resort while checking for any remaining skiers. Any skiers they find are escorted down. Once all lift operators have reached the resort the safety manager may formally declare the shutdown to be complete.

   Use an activity diagram to show how the individual activities in this description combine to create the workflow for this process. Pay particular attention to the synchronisation of activities. [*8 marks*]

   (c) The following preliminary class model has been suggested for implementing part of SLIP:



   CRC cards can be used to validate a class model such as this by detecting potential problems. Name the 5 main things you can detect by using CRC cards. [*5 marks*]

(d) Two more detailed use cases are suggested below. For each of them, construct sequence or collaboration diagrams for a representative scenario and use this diagram to check the validity of the class diagram given above. Identify any errors in the class diagram.

i. The senior lift controller initiates a bad weather shutdown, instructing all lifts that they must refuse to let any new skiers use them. [*4 marks*]

ii. The senior lift controller identifies a particular lift as faulty and orders it to shut itself down. This lift must also inform any skiers or instructors who attempt to use it that it is no longer usable. [*4 marks*]

2. *Note: ensure that you have read the introductory text on page 1 of this paper before attempting any questions.*

   (a) With what objects should an object O be able to communicate in dealing with a message m? Whose *Law* names this concept? [*5 marks*]

   (b) Use noun-phrase identification, or any other appropriate technique, to construct a class model from the following description of SLIP. Note that, as SLIP is expected to audit the operation of the lifts, any events associated with the lifts should also be treated as classes. The preliminary class model should identify the classes and their associations, but need not specify attributes or methods. You should label the associations with suitably descriptive labels and any multiplicities. [*8 marks*]

   > Ski-passes may be charged ("topped-up") at any sales-point. The ski-passes are scanned by lifts. There are three varieties of lifts: button-lifts; chair-lifts; and cable-cars. Every skier should carry a pass and uses this to travel on a variety of lifts. Lifts may be either automatically or manually started and stopped at any time. Lifts may also instigate an emergency stop under appropriate circumstances. Finally, there a set of auditing routines which monitor usage of both the lifts and the sales-points.

   (c) Using your above class model as an example, describe *functional testing* (or "black-box" testing) and how it may be used to validate this system. Include in your description any typical alternative strategies for functional testing. [*8 marks*]

   (d) The management of Val D'Aree intend that SLIP will support the running of the resort for many years; consequently it will require *maintenance*. Name any two types of software maintenance and, for each, a reason why you might expect SLIP to require such maintenance. [*4 marks*]

3. *Note: ensure that you have read the introductory text on page 1 of this paper before attempting any questions.*

(a) Define the meaning of *coupling* and *cohesion* in the context of object-oriented systems and, for each, state whether it is better for it to be low or high. [*4 marks*]

(b) The primary activities to be supported by SLIP are as follows:

> Skiers purchase ski-passes from any sales-point. There are a number of sales-points in the village of Aree and one at each mountain-restaurant. Skiers may also use the sales-points to "top-up" an existing ski-pass, either extending its duration or the number of lifts for which it is valid. At the end of each day the sales-points automatically record their total cash takings for that day. Skiers and Instructors travel on ski-lifts. Lifts can automatically scan the ski-pass of a skier or instructor to determine whether their pass is valid for that lift. Instructors carry miniature ski-pass scanners which also allow them to check the ski-passes of skiers. Instructors, when escorting a school of skiers, may select certain lifts and re-program them to temporarily accept as valid any ski-passes belonging to their school. The lifts themselves maintain a daily record of the traffic that uses them, and also can automatically run diagnostic routines on themselves as necessary.

Construct a use case diagram and corresponding use cases from the above description of SLIP. [*8 marks*]

(c) List the four top-level issues considered in deployment planning. [*4 marks*]

(d) Describe, with some details, any 3 common pitfalls of software reuse. [*9 marks*]