Student ID: . . . .

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI

VICTORIA

UNIVERSITY OF WELLINGTON

EXAMINATIONS – 2013

TRIMESTER 2

SWEN 102

Introduction to Software Modelling

Relevant Questions for ENGR110

Time Allowed:

Instructions:

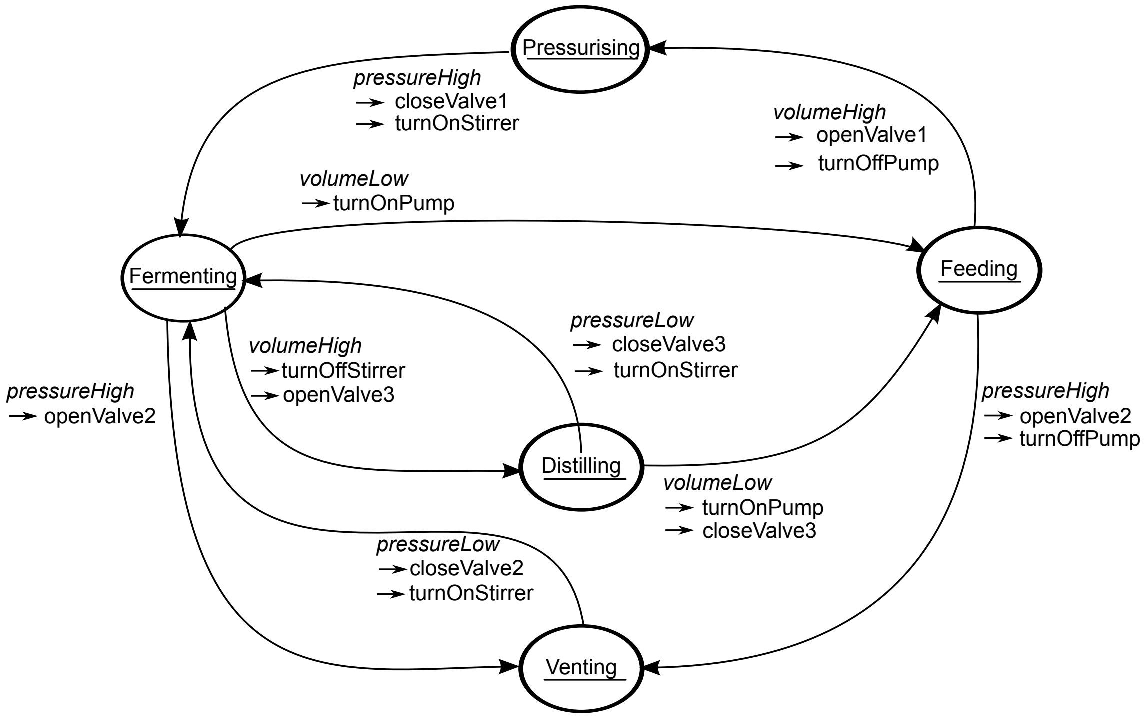
Model Solutions

- Closed Book.
- Answer all questions in the boxes provided.
- Every box requires an answer.
- If additional space is required you may use a separate answer booklet.
- No calculators are permitted.
- Non-electronic Foreign language dictionaries are allowed.

Question	Topic	Marks
1.	Finite State Machines (FSMs)	30
2.	Use Cases	30
3.	Class Diagrams and Requirements	30

Question 1. Finite State Machines (FSMs) [30 marks]

(a) [5 marks] The following diagram shows a FSM controller for a fuel-ethanol plant. The sensor signals for each transition are in italics.



Suppose the controller was in state Pressurising, and the fuel-ethanol plant then generated the following sequence of sensor signals:

pressureHigh, volumeHigh, pressureLow, volumeLow, pressureHigh

Show the sequence of actions the controller would output and the new states the controller would transition to in response to each sensor signal. The first line is done for you.

pressureHigh:	closeValve1, turnOnStirrer, Fermenting
volumeHigh:	turnOffStirrer, openValve3, Distilling
pressureLow:	closeValve3, turnOnStirrer, Fermenting
volumeLow:	turnOnPump, Feeding
pressureHigh:	openValve2, turnOffPump, Venting

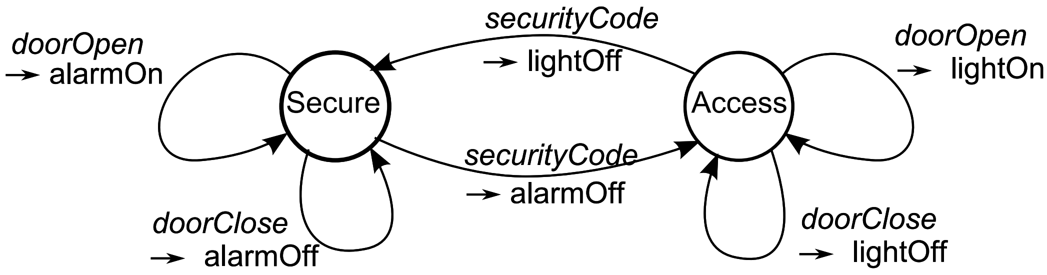
(Question 1 continued on next page)

(Question 1 continued)

(b) [8 marks] Consider the following FSM controller for a fridge with a security feature.

The fridge has a sensor that signals when the door is opened (`"doorOpen"`) or closed (`"doorClose"`) and another that signals when a person enters the correct security code on the key pad on the door (`"securityCode"`).

The possible actions the controller can perform are alarmOn, alarmOff, lightOn, and lightOff.



On the facing page, show how this controller could be implemented in a Java program by completing the signal method.

Assume that the signal method is called every time a sensor event occurs, and that for each action above, there is a corresponding method that can be called on the value of the fridge field.

(Question 1 continued on next page)

(Question 1 continued)

```
public class FridgeController {
  private String state = "Secure";
  private Fridge fridge;

  public void signal(String sensor){
      if (state.equals("Secure")){
         if (sensor.equals("doorOpen")) {
            fridge.alarmOn();
         }
         else if (sensor.equals("doorClose")){
            fridge.alarmOff();
         }
         else if (sensor.equals("securityCode")){
            fridge.alarmOff();
            state = "Access";
         }
      }
      else if (state.equals("Access")){
         if (sensor.equals("doorOpen")) {
            fridge.lightOn();
         }
         else if (sensor.equals("doorClose")){
            fridge.lightOff ();
         }
         else if (sensor.equals("securityCode")){
            fridge.lightOff ();
            state = "Secure";
         }
      }









}
```

(Question 1 continued on next page)

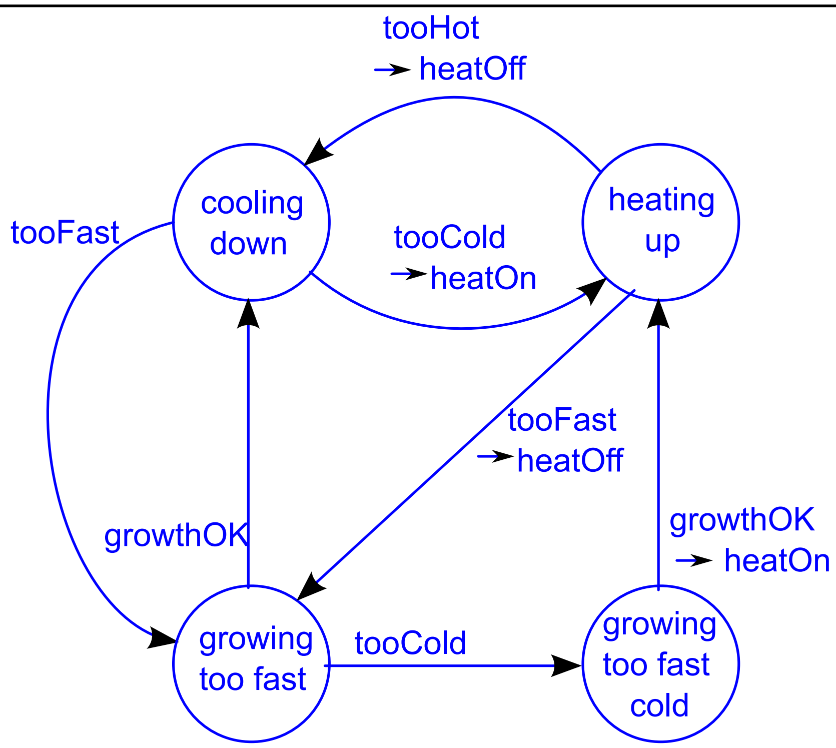
(Question 1 continued)

(c) [12 marks] Draw the design of a FSM controller for the following cell-growing machine.

The machine contains a heating element which can be turned on and off (`"heatOn"`, `"heatOff"`).

The machine has two sensor devices: a thermometer and a laser detector. The thermometer signals `"tooHot"` whenever the temperature rises above 39 degrees, and `"tooCold"` whenever it falls below 38 degrees. The laser detector signals `"tooFast"` when the growth rate of the cells rises above 50μgm/min, and `"growthOK"` when it falls to 40μgm/min.

The controller should generally keep the temperature between 38 and 39 degrees by turning the heating element on and off. However, if the growth rate goes above 50μgm/min, the controller should ensure the heater is off and stays off until the growth rate slows to 40μgm/min. It should then attempt to get the temperature to between 38 and 39 again.



(Question 1 continued on next page)

(Question 1 continued)

(d) [5 marks] Event-based FSM controllers are just one kind of FSM. Briefly describe **two** other kinds of FSM, indicating the ways in which they are different from the event-based FSM controllers. You may use diagrams in your answer if you wish.

Any two of the following:

- Continuous time FSM controllers - the controller tests the sensors continuously, and has self transitions for when the state doesn't change.
- Non-deterministic FSM generators, which may have several transitions out of a state either with no contidtions, or the same condition.
- Probabilistic FSMs with several transitions out of a state, marked with probabilities.
- Hidden Markov Models where the states have probability distributions on the output as well as on the transitions.
- FSM acceptors, with symbols on the transitions but no output, and have some states marked as accepting or final states.

Question 2. Use Cases [30 marks]

(a) [3 marks] Perform a *textual analysis* on the following description, by carefully and neatly underlining key verb phrases that could lead to candidate use cases.

Air NZ is a commercial airline flying within New Zealand. Air NZ has a Frequent Flyer Program where frequent travellers accumulate airpoints. Once a frequent flyer account is created, a traveller accumulates airpoints after each flight he/she takes. Travellers who accumulate more than 480 airpoints in a given year are given "Gold Status".

Gold Status travellers are entitled to two complimentary flight upgrades from economy class to premium economy class. Gold status members must request upgrades via the website at least 48 hours in advance.

Before boarding a flight, Gold Status passengers may enter the Air NZ Lounge where food and drinks are served. To gain entry, they must have a valid boarding pass for an Air NZ flight. A barcode on the boarding pass is scanned to confirm this, and other passengers are turned away.

Announcements for departing flights are made within the Air NZ Lounge. This is done by the lounge manager who has the schedule of departing flights. Before making the announcement for a flight, the manager logs on to the system to check whether the flight is delayed and whether or not there are any passengers currently in the lounge on that flight.

Seats on Air NZ flights are allocated by the flight attendants on the day of travel. Seating preferences are given to Gold Status passengers first, followed by everyone else. Travellers with a Frequent Flyer account may access the system to check their seat ahead of time.

(Question 2 continued on next page)

(Question 2 continued)

(b) [12 marks] Provide **use case descriptions** for the main success sequence of the following **three** use cases.

Request Upgrade

Enter Air NZ Lounge

Departing Flight Announcement

(Question 2 continued on next page)

(Question 2 continued)

(c) [9 marks] Draw a **use case diagram** showing at least 3 actors and at least 6 use cases that you would produce in a model of this system.

(Question 2 continued on next page)

(Question 2 continued)

(d) [6 marks] Give characteristics for two actors in the system.

1. **Actor Name**
2. **Domain Knowledge**
3. **System Knowledge**
4. **Frequency of Interaction**

1. **Actor Name**
2. **Domain Knowledge**
3. **System Knowledge**
4. **Frequency of Interaction**

Question 3. Class Diagrams and Requirements [30 marks]

(a) [15 marks] Based on the description from Question 1 on Page 7, draw a *well-designed* **class diagram** to model the Air NZ system. This should contain at most 6 classes and 10 attributes and use inheritance and associations where appropriate.

(Question 3 continued on next page)

(Question 3 continued)

(b) [5 marks] In the box below, draw an *object diagram* consistent with your class diagram which captures the following scenario:

> "Dave, a university lecturer, was travelling from Wellington to Auckland on Air NZ flight NZ432. Dave is a frequent flyer who attained Gold Status last year. With 20 mins before boarding, Dave was in the Air NZ Lounge having a coffee. His boarding pass indicated he would be sitting in seat 1C for the flight."

(Question 3 continued on next page)

(Question 3 continued)

(c) [5 marks] Briefly, discuss what *functional requirements* are. You should include at least one example of a functional requirement for the Air NZ system.

(d) [5 marks] Briefly, discuss what *non-functional requirements* are. You should include at least one example of a non-functional requirement for the Air NZ system.

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