

NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 1 EXAMINATION 2018-2019

CE2006/CZ2006 – SOFTWARE ENGINEERING

Nov/Dec 2018

Time Allowed: 2 hours

INSTRUCTIONS

1. This paper contains 4 questions and comprises 6 pages.
2. Answer **ALL** questions.
3. This is an open-book examination.
4. All questions carry equal marks.
5. Refer to **Appendix A** on page 6 for the project description which is needed to answer some of the questions.

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1. Based on the project description given in Appendix A,
 - (a) Identify the actors and use cases of the project and draw the use case diagram. Use <<include>> and <<extend>> relationships where appropriate.
(10 marks)
 - (b) Write the use case description for the functionality of the membership status verification including any included use case if it exists. Your use case description must include description of the use case, flow of events and any alternative flow if it exists.
(7 marks)
 - (c) Draw the activity diagram for the claim submission activity done by a provider after a health care service has been provided to the customer.
(8 marks)

2. (a) From your use case description in Q1(b), identify the main classes and their associations and draw a conceptual class diagram that depicts the classes including their stereotypes (i.e., Boundary, Control, and Entity) and associations between them. You do not need to identify any attribute or operation within the classes. (8 marks)
- (b) Draw a state machine diagram that shows the states and transitions of the member verification component of the system. (9 marks)
- (c) Figure Q2(c) shows the network diagram of tasks in a small project (where “A3” means that 3 weeks are needed to complete task A).

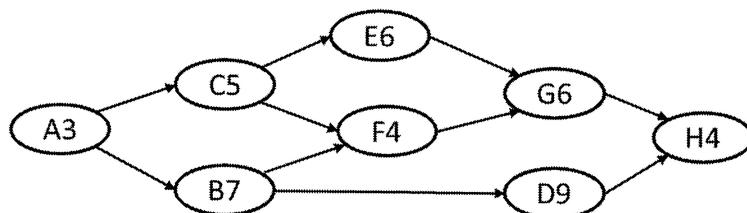


Figure Q2(c)

- (i) Use forward analysis and backward analysis to identify the critical path(s). (5 marks)
- (ii) Calculate the shortest time for the project to complete. (1 mark)
- (iii) Show the slack time values for tasks D and F. (2 marks)

3. (a) Refer to the classes identified in your answer to Q2(a).
- (i) Apply Layered Architecture to model the classes. Draw the layered architecture diagram and state clearly each layer name on the diagram. For each layer, indicate clearly whether it is a boundary, control, or entity analysis class.
[You may use symbols to indicate the three analysis classes on the diagram].
- (4 marks)
- (ii) For each layer of the layered architecture diagram drawn in Q3(a)(i) above, provide TWO classes from your class diagram drawn in Q2(a). Provide additional classes not included in the diagram drawn in Q2(a), if needed. Indicate clearly the dependencies between the layers and/or classes on the layered architecture diagram.
- (4 marks)
- (iii) Use ONE to TWO sentences to explain the core responsibilities of each analysis class: boundary, control, and entity.
- (3 marks)
- (b) Suppose a new feature has been proposed for CAIS to support its current active members who receive health care services from CheAn's health care providers: Current active members can register their interest in certain types of news information such as Appointments, Memberships, Providers, Services, and CheAn organization. CAIS sends notifications to the registered active members for the types of news information they are interested in.
- (i) Identify and explain briefly TWO design problems in the design of the new feature.
- (4 marks)
- (ii) Propose an appropriate design pattern to address the design problems identified in your answer to Q3(b)(i). Briefly explain the mechanisms to adopt from the proposed design pattern to support the new feature.
- (3 marks)
- (iii) Depict the application of the design pattern proposed in Q3(b)(ii) in a Class Diagram. Explain briefly the roles each class plays in the proposed design pattern.
- (7 marks)

4. (a) From the initial CAIS project description in Appendix A, consider the following two requirements, R1 and R2 for a provider to submit a claim after a health care service has been rendered to an active member.

R1: The date of service must be entered in the format as DD-MM-YYYY, i.e., a 2-digit day, followed by a dash, followed by a 2-digit month, followed by a dash, and followed by a 4-digit year. For example, 08-11-2017 is a correct format, whereas 11-08-2017 and 8-11-2017 are incorrect format. [*A digit is from 0 to 9 inclusive.*]

R2: The number of digits for the service code must be minimum 4 digits to maximum 6 digits. For examples, 0000 and 999999 are valid service codes, whereas 000 and 9999999 are invalid service codes. [*A digit is from 0 to 9 inclusive.*]

- (i) Determine the equivalence classes for R1 and R2.
[*For R1: Consider ONLY the format of the date of service; you do not need to consider invalid day, month, and/or year.*
For R2: Consider ONLY the number (i.e., length) of digits; you do not need to consider characters.] (3 marks)
- (ii) Determine the boundaries of the equivalence classes identified in your answers to Q4(a)(i). For each boundary, determine the value(s) *on* the boundary, a value *just below* the boundary, and a value *just above* the boundary. (4 marks)
- (iii) You intend to perform **defensive testing** of the two claim submission requirements, R1 and R2. Design a set of test cases to test R1 and R2 based on the equivalence classes and boundary values identified in your answers to Q4(a)(i) and Q4(a)(ii).
[*For R1: You do not need to create test cases for invalid day, month, and/or year; you need to create test cases to test ONLY the format of the date of service and create test cases for at least two invalid values on the format of the date of service.*] (5 marks)

- (b) Based on the initial CAIS project description in Appendix A, upon the request by the CheAn manager, the system generates the Provider report containing all claims submitted by a particular provider for services rendered to a given member. The *findByMember* method (as shown in the Java code snippets in Figure Q4(b)), public *ArrayList<Claim> findByMember (long memberNumber)* finds all the claims for services rendered to a given member.

Note: Question No. 4 continues on Page 5

Given a list (i.e., *ArrayList*) of member claims (i.e., *memberClaims* of class *Claim*), the *findByMember* method implements the bubble sort algorithm to sort the member claims by service date.

- (i) Draw the control flow graph for the *findByMember()* method.
[Use line numbers on process blocks and decision points for clarity.] (5 marks)
- (ii) Calculate the Cyclomatic Complexity of the *findByMember()* method. (2 marks)
- (iii) List the basis set of linearly independent paths for performing basic path testing of the *findByMember()* method. Design a test case (including the input parameters to the *findByMember()* method and expected outcome) for each of the basic paths. (6 marks)

```
/** The findByMember() method finds all the claims for services rendered to a given
member.
Class Claim returns a string representation of the claim consisting of the values of all
the instance variables, i.e. submission date, service code, provider name, member
number, and service date, separated by the character '#'.
@param memberNumber the member's number.
*/
1 public ArrayList<Claim> findByMember (long memberNumber) {
2     ArrayList<Claim> memberClaims = new ArrayList<Claim>();
3
4     // Adding of member claims to the memberClaims list is omitted here.
5
6     // Sort by service code using a bubble sort algorithm
7     for (int i = memberClaims.size() - 1; i > 0; i--) {
8         for (int j = 0; j < i; j++) {
9             if (memberClaims.get(j).getServiceDate().after(memberClaims.get(i)
10                .getServiceDate())){
11                 Claim temp = memberClaims.get(i);
12                 memberClaims.set(i, memberClaims.get(j));
13                 memberClaims.set(j, temp);
14             } // if
15         } // for
16     } // for
17     return memberClaims;
} // findByMember
```

Figure Q4(b)

Appendix A

CheAn Information System (CAIS) Description

Cheeseholics Anonymous (CheAn) is an organization dedicated to helping people addicted to cheese. The organization is planning to have a software system (CheAn information system, CAIS) to enable CheAn health care providers to submit a claim for a service provided to an active member and to support CheAn staff to verify a person's membership status and manage information about its current members and providers.

Initial CAIS Project Description

Every current member and provider is assigned a 9-digit member number. They pay a monthly fee on the system to ensure an active membership with CheAn. Only active members can receive unlimited consultations and treatments with the active providers. The membership information is stored in an external CheAn Data Centre whereas processing of membership fees is handled by a third-party company Acme Accounting Services. Current active members, providers and the CheAn manager are required to log in to the system in order to use the system. The login information is stored locally in the system. The system also enables a potential member to apply for a membership.

To verify a member before a member can receive health care services from CheAn,

- The member provides the member number to the system for verification.
- The system then connects to the external CheAn Data Center computer to verify the member number.
- If the number is valid, the system connects to the Acme Accounting Services to check the membership fee payment status.
- If both the number and the payment status are valid, the word "Validated" appears on the screen. Otherwise, the message "Invalid number" or "Member suspended due to owned fees for at least a month" or any other reason for the suspension is displayed.

To submit a claim to CheAn after a health care service has been provided to the member,

- The provider keys in the provider number on the system to confirm that he/she is an active provider.
- When the word Validated appears, the provider keys in the member number of the service recipient and the service date in the format MM-DD-YYYY.
- Next, the provider keys in the 4-6-digit service code corresponding to the service provided. For example, 123456 is the code for an aerobics exercise session.
- The system displays the name of the service corresponding to the code (up to 20 characters) and asks the provider to verify that this is the service that was provided.
- If the provider has entered a non-existent code, an error message is displayed.
- The system next looks up the fee for that service and displays it on the screen.

The system enables the CheAn manager to request to view a number of reports, namely Member report, Provider report, and Accounts Payable Summary report. The manager may request the system to print a selected report.

END OF PAPER

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Please read the following instructions carefully:

- 1. Please do not turn over the question paper until you are told to do so. Disciplinary action may be taken against you if you do so.**
2. You are not allowed to leave the examination hall unless accompanied by an invigilator. You may raise your hand if you need to communicate with the invigilator.
3. Please write your Matriculation Number on the front of the answer book.
4. Please indicate clearly in the answer book (at the appropriate place) if you are continuing the answer to a question elsewhere in the book.