

DAT321/DIT843: Quality Assurance and Testing

Questions about the exam contact:

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For questions about the exam, call the number above.

Allowed Aid:

- English dictionary
- **NOT ALLOWED:** Anything else not explicitly mentioned above (including additional books, other notes, previous exams, or any form of electronic device: dictionaries, agendas, computers, mobile phones, etc.)

The questions in this exam refer to the **ISO 25010:2011** that categorises internal and external software quality attributes into eight characteristics, as well as the quality in use characteristics.

Important advice:

- Each question has points assigned shown in the square brackets. When the question is broken down into smaller sub-questions the part of the points for those specific sub-questions are also shown. Example: 1. [10 pts]. 1a. [2 pts] 1b. [8 pts].
- You must write clear, readable, understandable, and unambiguous answers. If we cannot easily read what you are trying to write, then we cannot positively judge your knowledge and you will most likely fail.
- Motivate your answers (a simple statement of facts not answering the question is invalid). Whenever possible refer to modules, features and information about the software product or software development process described in the context.
- Start each question on a new paper. Sort your answers in order (by question and sub-task) before handing them in.
- Write your student code on each page and put the number of the question on every paper.

The points and the corresponding grade are presented below (100 points in total):

- 00 – 49: U (Fail)
- 50 - 69: 3 (Pass)
- 70 - 89: 4 (Pass with credit)
- 90 - 100: 5 (Pass with distinction)

The exam review will be done via Zoom scheduled for:

Date: 2022-02-03 between 14:00 – 15:30.

Zoom Link: <https://chalmers.zoom.us/j/6651614233>

Password: DIT043

Description of Context:

The questions in this exam are related to the context below. Note that you **must** justify your exam answers with i) the theory and terminology from the subject studied during the course and ii) their connections to the elements in this context, such as the teams, product, processes, architecture, customers, system under test (SUT), etc.

You are hired by the company Vaccine-Co responsible for handling the booking of COVID-19 vaccines during the current pandemic. This system will be deployed in a country where none of the population has started being vaccinated yet. Vaccination of people in the risk groups is ongoing already by another agency. There are still circa 20 million individuals outside the risk groups (age between 18 – 50 years old) that are eligible for the vaccine and should receive them as soon as possible. Healthcare in this country is public and accessible to all, meaning that everyone will be vaccinated for free. The goal is to release our software product within two months. This is a high priority of the company as the government and media create pressure to book vaccines.

Features and architecture of the product:

The software product uses a publish/subscribe architectural style (Figure 1), where each component is independent of each other. Their communication is handled by a **Broker Component** that sends and receives messages between components.

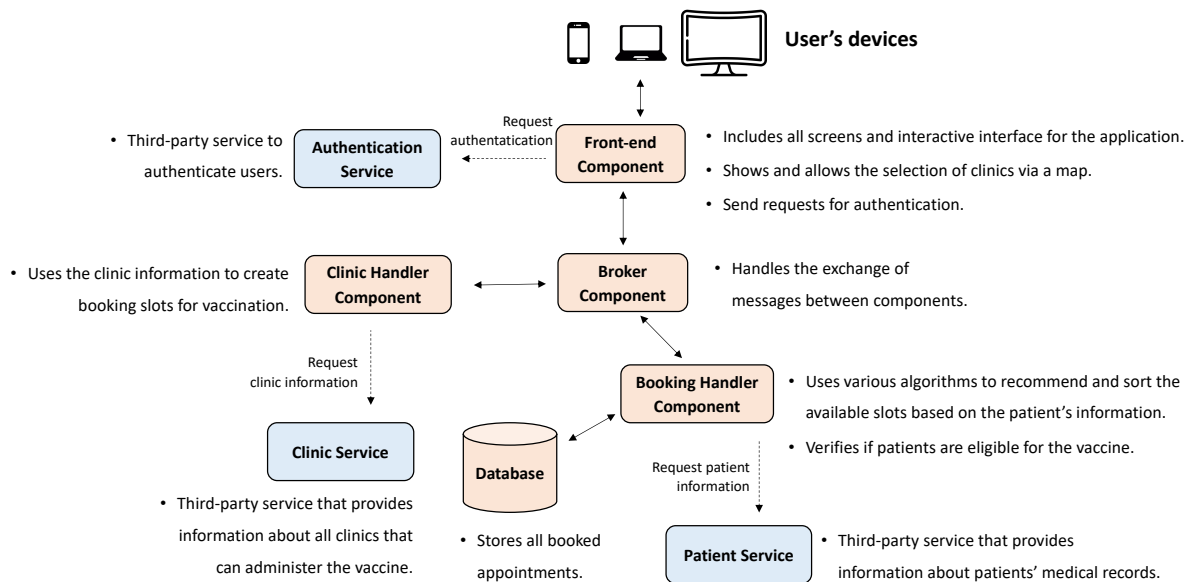


Figure 1 – Architecture of the Software Product

The graphical user interface (GUI) of your system can be accessed by end-users in different devices such as mobile phones, personal computers, and tablets. The variations of interface and messages/requests sent from the device are handled by the **Front-end Component** which is installed in the user's device. To access the software, users must first login using their social

security number. The authentication is done by a third-party application via the **Authentication Service** and is not developed by your organization.

Your system retrieves the information of clinics that administer the vaccine (opening hour, staff, available doses, etc.) from a **Clinic Service**. That service is hosted and handled by the public healthcare agency, such that you cannot alter the registry. The **Clinic Handler Component** is responsible for fetching that information as well as creating the vaccination slots and storing them in our own database.

Our system has a **Booking Handler Component** that suggests specific vaccination slots to users. Those slots are sorted based on the patient's medical records (e.g., age, past diseases, and treatments) retrieved from the healthcare **Patient Service**. The goal is to prioritise available slots to patients more vulnerable to COVID-19. The booked appointments are then stored in a **database**.

Your team has access to the source code and documentation of all components. However, the owners of the services (Authentication, Clinic and Patient) only provide documentation explaining the services' features such that you do not have access to their source code.

Development process and team:

There is only one development team named Team X composed of 8 people: three developers, one architect, one product owner, one process manager, one user-experience (UX) designer, and one quality assurance engineer (you). Your entire team has worked with agile development and Continuous Integration (CI) in the past. However, the toolchain to create a CI pipeline in your development process is not done yet and your team will have to create one.

1. [30 pts] Using the context above, answer the following questions:
 - a. [15 pts] Choose **three** software product quality's characteristics, **and, for each**, provide examples of why they are relevant to the software product at Vaccine-Co. When justifying your choices, you **must** use the features and components/services listed in Figure 1 as sources for your examples.
 - b. [10 pts] Choose **two** metrics to assess the external quality of our system. For each chosen metric you should: (i) indicate one or more components to collect that metric, (ii) the quality characteristic/attribute associated with your chosen metric (it can be the same characteristic for both metrics), and (iii) the purpose of that metric for the chosen component(s).
 - c. [5 pts] Vaccine-Co wants to promote sustainability in the product that we are creating. Using the Sustainability Awareness Framework, you must (i) **choose or suggest one functionality for our vaccine booking system** and explain the (ii) immediate, (iii) enabling and (iv) structural effects of those features. You must also indicate the **corresponding type/dimension of sustainability** in which those effects occur.
2. [25 pts] Considering the decision to introduce Continuous Integration to the development team, answer the following questions:
 - a. [8 pts] Write **two tools** required to implement a Continuous Integration pipeline. For each chosen tool, you must explain the benefit that they bring to the development cycle in a CI pipeline.
 - b. [7 pts] List **two development practices/activities** necessary to successfully use Continuous Integration. Justify why those practices are relevant for CI.
 - c. [10 pts] Regression testing enables the identification of regression faults. However, one of the risks with regression testing in modern software development is the lack of time or resources to run all regression tests. Choose and explain **one regression testing technique** that can be used to reduce the costs with regression tests. Your explanation must include **how** the chosen technique makes regression testing more cost-effective.

3. [20 pts] Considering the context for Vaccine-Co and your knowledge of levels of testing and types of testing techniques, answer the questions below:
- [7 pts] Explain **one advantage and one disadvantage** of white-box testing techniques. Choose **one component or service** from Figure 1 where a white-box technique can be used to create test cases and justify your choice.
 - [8 pts] Explain **one advantage and one disadvantage** of black-box testing techniques. Choose **one component or service** from Figure 1 where a black-box technique can be used to create test cases and justify your choice.
 - [5 pts] Choose **one component or service** from Figure 1 that would be a good candidate for doing integration-level testing. Justify your choice of component.
4. [25 pts] The code below is a method used to concatenate words in an array. The method has two input values: (i) an array of words to be concatenated and (ii) a string to be used as separator between those words. The output is a single string where all elements of the array are concatenated and separated by the separator string. For invalid input values (null values or an empty array) the method returns an empty string as result. Using your knowledge of different testing techniques, answer the questions below:

```
// Method to paste together words from an array
// using a specific separator.
public static String concatenateWords(String[] words, String separator){

1.     //If the array is empty, or the method received
2.     //  null values, return empty string.
3.     if(words == null || separator == null || words.length == 0){
4.         return "";
5.     }
6.
7.     String result = "";
8.     //Concatenate each word with the separator, except for the last.
9.     for (int i = 0; i < words.length - 1; i = i + 1) {
10.        // '+' concatenates strings in Java.
11.        result = result + words[i] + separator;
12.    }
13.
14.    //Note that the separator is not added when
15.    // concatenating the last word.
16.    return result + words[words.length - 1];

}
```

- a. [7 pts] Using Property-based testing (PBT) write down **at least three properties** for verifying the method `concatenateWords`. You should write the properties using natural language.

- b. [8 pts] Write **at least three equivalence partition** classes that can be used to test the method below. Use the method under test (specification or code) to justify your choice of partition classes.

- c. [5 pts] Using Boundary Value Analysis (BVA), write **at least four test cases** (input and expected output) that exercise the boundaries of the partition classes you identified above.

- d. [5 pts] Choose **one mutation operator** and create one mutant of the `concatenateWords` method. You must indicate the line of code(s) where the mutation is done.