

Written exam for Software Engineering Theory

Course codes TDDC88, TDDC93, 725G64

Note: When I visit the exam, I will take a slow walk among all students, so you don't need to sit with your hand raised. Just call for my attention when I pass your desk.

Instructions to students, please read carefully

- **Explicitly forbidden aids:** Textbooks, machine-written pages, photocopied pages, pages of different format than A4, electronic equipment.
- Try to solve as many problems as possible.
- Motivate all solutions.
- Please, write and draw clearly.
- Write solutions for different areas (fundamental part) and different problems (advanced part) on separate sheets of paper.
- Label all papers with AID-number, date of examination, course code, examination code, and page number.
- You may write solutions in either Swedish or English.
- Please, note that the problems are not necessarily written in order of difficulty.
- **TIP!** Read through all exercises in the beginning of the exam. This will give you the possibility to ask questions about all parts of the exam, since the examiner will visit you in the beginning of the exam time.

Grading

The exam consists of two parts: Fundamental and Advanced.

The Fundamental part has problems worth 10 credits per area. Areas are: Requirements, Planning & Processes, Design & Architecture, Testing & SCM, and Software Quality. Thus the Fundamental part can give maximally 50 credits.

The Advanced part has problems worth 50 credits in total. Each problem typically requires a longer solution of several pages.

The maximum number of credits assigned to each problem is given within parentheses at the end of the last paragraph of the problem.

Pass condition: At least 4 credits per area in the Fundamental part **and** at least 50 credits in total. The total amount of credits also includes the bonus credits you might have got in lecture exercises autumn 2016. This gives you the mark 3. If you have at least 4 credits for 4 of the areas in the Fundamental part, then you can still pass if you have more than 60 credits in total.

Higher marks are given based on fulfilled *pass condition* **and** higher amounts of credits according to the following table:

Total credits	Mark
0-49	U (no pass)
50-66	3
67-83	4
84-	5

Multiple choice questions

In multiple choice questions we will ask you to write down the letters A, B, C, or D for the one or two statements that you think are true. Note that you should not write down the statements that you think are false. There are exactly two true statements per question, so answering with three or four alternatives with gives 0 credits.

For each statement that you select that is correct (i.e., that the statement is in fact true) you get one credit. For each statement that you select that is incorrect (i.e., that the statement is in fact false, but you believed it was true) you get minus one credit. Each multiple choice question can give maximum 2 credits and minimum 0 credits, i.e., you cannot get negative credits for one multiple choice question.

Example 1: Assume that you have written down statements A and C. If now statements A and B were true, and statements C and D were false, you would get +1 credit for writing down A, but -1 credit for writing down C. Hence, the total credits for the multiple choice question is 0.

Example 2: Assume that you have written down statement B. If now statement A and B were true, and statement and statement C and D were false, you would get +1 credit for the multiple choice question.

Example 3: Assume you correctly wrote both statement A and B. If now statement A and B were true, and statement and C and D were false, you would get +1 credit for writing down A, and +1 for writing down B. Hence, the total credits for the multiple choice question is 2.

Good Luck!

Kristian

Problems

Part 1: Fundamental

Area 1: Requirements

1 a) Which of the following statements are true? Answer with the statement letter only, no motivation is needed. (2)

- A. The statement “The system has been well received by parents.” is a requirement since it describes the system.
- B. The statement “The system shall be fast.” is not a good requirement since “fast” is vague.
- C. The statement “The maximum response time of the system is 300 ms.” is a functional requirement.
- D. The statement “As a student I want to access the library remotely so that I can study from home.” is an example of a user story text.

1 b) Scenario: In the future all written exams shall be made with a computer. A brainstorming session generated the following ideas: Students and exam invigilators use the system for identification and other administrative things. Students can write answers, including drawing diagrams. Students can access allowed reference material, grammar, and spell checks. Examiners and other teachers are online to answer questions and grade tasks marked ready by the students. Students can read the results afterwards. Examiners can set up rules of how the final grade can automatically be calculated. Invigilators can file reports of improper acts during the exam. Administrators can retrieve results for LADOK registration.

Task 1: Write two use-cases of the system described above and draw a UML use-case diagram. At least three different actors shall be involved in the two use-cases, for instance, one actor in use-case 1 and two other actors in use-case 2. (4)

Task 2: Write a quality requirement and one design constraint of the system described above. For each of the two requirements, write a short motivation on which level of testing (unit, integration, ...) they can be tested. (Hint: a motivation is typically 1-2 sentences.) (4)

Area 2: Planning and Processes

2 a) Which of the following statements are true? Answer with the statement letter only, no motivation is needed. (2)

- A. The Risk Magnitude Indicator is the product of probability and impact of an identified risk.
- B. Risk mitigation is a process of finding ways so that someone else is taking the risk.
- C. The risk “Our lease of testing hardware will end before our tests are ready” is a direct risk.
- D. For a student project of 6 credits, you should at least expect to manage 20-50 risks.

2b) Describe two differences between SCRUM and Kanban. (4)

2c) Assume that you have a contract with the customer stating that a list of features must be present in the coming release. Give examples of things you can do if:

- Two people leave the project.
- Your manager wants you to deliver the product a month earlier.
- Your strategic product owner decides that you need to deploy on more platforms than was originally agreed.

We don't assume that all the above problems occur simultaneously, just account for them one by one. (4)

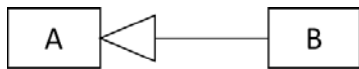
Area 3: Design and Architecture

3 a) Which of the following statements are true? Answer with the statement letter only, no motivation is needed. (2)

- A. The composition association implies “no sharing”. Instances of B can only be owned by a single instance of A in the diagram:



- B. Generalization means that A inherits all properties and operation of B in the diagram:



- C. The Observer design pattern can be used when we need to use different variants of the same algorithm in a class.
- D. The Façade design patterns can be used to provide a simple interface to a complex subsystem.

3 b) Give four examples of things you want to document about an architecture. For each example, add a sentence describing how a reader of the document can use the information. (4)

3 c) Draw a UML Sequence diagram describing the interaction with the student and exam invigilator, invigilator’s computer and invigilator’s lists during our present exam. You start with the student entering the room, and end when handing in the exam (hopefully with very good solutions). Use fragments so that you cover the cases when:

- the student is not registered to the exam in beforehand and must wait 30 minutes
- the student needs multiple WC breaks

(4)

Area 4: Testing and SCM

4 a) Which of the following statements are true? Answer with the statement letter only, no motivation is needed. (2)

- A. Testing cannot detect missing functionality (sins of omission).
- B. A fault is observed once a failure of the software is executed.
- C. An error denotes a human mistake done during coding.
- D. Equivalence class testing is based on the specification.

4 b) Describe the process of Test-Driven Development (TDD). What is the alternative to TDD? What benefits are proponents of TDD expecting to accomplish. (4)

4 c) Explain with an example what happens in Git when you give the following commands: clone, pull, push, and commit. (4)

Area 5: Software Quality

5 a) Which of the following statements are true? Answer with the statement letter only, no motivation is needed. (2)

- A. In the staged representation of CMMI an organization can be rated to a specific maturity level by satisfying a predefined set of process areas.
- B. To be rated at level 1: Initial in the staged representation of CMMI you need to satisfy process areas in process adherence and requirements management.
- C. Each process area in CMMI has a number of specific and generic goals that all have to be met in order to satisfy the process area
- D. To meet a specific goal of a CMMI process area you must follow the specific practices given in the SEI standard.

5 b) Explain how you measure Cyclomatic complexity, $V(G)$, of a software component. You may use an example. Give at least two quality factors that can be (partially) related to $V(G)$. For each quality factor, write a short motivation of why you think it is related to $V(G)$.

(4)

5 c) Describe four different kinds of data that you record from an inspection together with a short motivation of how you can use the information. (4)

Part 2: Advanced

6. Scenario: You are about to develop a decision support system for the migration board in order to make applications of immigration of workforce and refugees faster and more consistent. The stakeholders are: the applicant, the case officer, managers at the migration board, the legal counsellor of the applicant, personnel in government overseeing the migration board, and judges at the appeal court. The system handles massive amounts of information from foreign department, laws, and precedents. Data about the applicants are very sensitive.

Task: Your task is to elicit and analyze the requirements for this system.

For elicitation, describe with an example of how each of the techniques listed below can be used. Name a stakeholder that is appropriate for the technique and describe what requirements you expect to find by using:

- a) Personal interviews
- b) Workplace observation
- c) Group discussions around a scenario
- d) Prototyping

For the analysis, suggest two ways of classifying the requirements. For each choice, give a one-sentence motivation.

(15)

7. Scenario: The scenario application is the same as in problem 6. Below is a sketch of a use-case description. It is sequential, but in real life the sequence contains loops since discovery of new information will affect the checklist for the case officer.

1. The case officer receives an application and opens a case with document templates.
2. The case officer checks the identity of the applicant and enters all background information. Free-text information is scanned and interpreted by the system.
3. Based on the information given the system detects missing or uncertain information and seeks rules that might apply. The case officer receives a checklist of information to gather and decisions to be taken. The officer can edit the checklist.
4. The case officer calls the applicant for an interview to complete information. The interview is recorded and the system parses the dialogue and updates the checklist for the case officer.
5. The case officer establishes the ID of the applicant and the systems checks in national and international police records.
6. If the applicant is a refugee, the system searches in databases of foreign department to establish a view of the situation for the applicant in the affected countries. A summary and references is sent to the case officer.
7. If the applicant is a workforce immigrant, the system checks documents about the prospective employer with tax authorities and trade unions. A summary and references is sent to the case officer.
8. When the checklist is empty the case officer takes the final decision and informs the applicant, affected authorities, and, if applicable, prospective employers about the result.

Task: You shall now begin designing the system by:

- a) Create an over-all architecture of a realization of the system. Draw a diagram of the major components and write a short description of how the system will work. You don't have to use UML, a box-and-line diagram with about 4-5 nodes will do. How do you handle the problem that some information is very sensitive? (5)
- b) Draw a UML Class diagram of the different actors and concepts used in the sketch of the use-case. Use at least one generalization. Classes shall contain attributes and operations whenever applicable. There shall be names of the associations. The goal is to create an analysis model showing the relations between the actors concepts in the use-case. No implementation details, for instance, design on machine learning algorithms are necessary. (20)

8. The recent applications of AI and machine learning are inspiring. Write a short reflection of how you could test such a system.

- Do all levels of testing of software engineering apply?
- How can you test a system where analytical expected output cannot be given in advance?
- What quality factors are the most important to test?

You may use an example. Motivate the statements you make. This is an open question and is judged on the quality of your motivations. (10)