

IDA

David Broman, Kristian Sandahl

## Written exam for Software Engineering Theory TDDC88, TDDC93

### *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 only on one side of the paper.
- 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, Design & Architecture, Testing, Planning & Processes, and Quality factors. 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.

Multiple choice questions will ask you to write down the label of two correct statements. Credits are given according to the following table:

Number of correct statements in the answer	Number of incorrect statements in the answer	Number of credits
2	0	2
2	1	1
2	2	0
1	0	1
1	1 or higher	0
0	any	0

**Pass condition:** At least 5 credits per area in the Fundamental part **and** at least 50 credits in total. This gives you the mark 3 in the Swedish system and a C in ECTS. First, we will report your credits on the written exam in LADOK. Then, in a second round, we will add the extra credits that are earned from the lecture exercises. The reason for this double procedure is that the exams are anonymous.

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

Total credits	Mark in Swedish system	Translation to ECTS
> 83	5	A
83-67	4	B
66-50	3	C
49-0	UK	Fx

*Good Luck!*

*David and Kristian*

# Problems

## Part 1: Fundamental

### Area 1: Requirements

**1 a)** Which of the following statements are true? Answer with the statement number only. No motivation is needed. (2)

1. The requirement “The system shall be implemented in Java.” is a functional requirement.
2. The requirements “A user of age 18 or higher shall be able to place an order.” and “A user of age less than 18 shall not be able to place an order.” are consistent requirements.
3. The requirements “It shall be possible to do file transfer with Bluetooth.” and “It shall be possible to do file transfer with Infrared link.” are mutually exclusive and thus inconsistent.
4. The requirements “The average user shall be able to log in in two seconds.” and “The maximum response time shall not exceed three seconds” are two non-functional requirements.

**1 b)** Draw a use-case diagram consisting of two use-cases and two *different* actors for the student portal at LiU. For example, I-students and D-students are *not* different actors in this respect. Each use case shall also have a description that shall contain one sentence for the initiation of the use-case and one sentence for the termination. At least two sentences shall describe the flow of events. (4)

**1 c)** It is well known that it can be hard to elicit the true needs of a customer and several approaches have been suggested. For each of the following approaches, write down one advantage and one disadvantage:

1. Prototyping. You develop prototypes of user interfaces every 14 days. The customer is observed when running the prototypes, and the observation data is used to iteratively create a full requirements specification.
2. Work-place observation. You visit the customer’s site several days a week and observe people doing their current tasks. Whenever possible, you ask them to think aloud. During work you take notes. Without intruding too much, you use coffee-breaks and lunches for follow-up questions.

(4)

## **Area 2: Design and Architecture**

**2a)** Which of the following statements are true? Answer with the statement number only. No motivation is needed. (2)

1. The deployment view is a good place to document and measure modules' coupling.
2. When a system design has low cohesion, i.e., different modules have few dependencies between each other, it can be considered well designed.
3. One of the main purposes when creating an architecture is to make use of commercial-off-the-self (COTS) products and reusable libraries.
4. When using UML modeling and round-trip-engineering, a tool can convert UML models to programming code and then back again.

**2 b)** Explain shortly and concisely the idea and main concepts of the architecture style *pipe-and-filter*. Explain and give clear examples for how filters connected in parallel or in series can both support concurrent computation. (4)

**2 c)** Create an UML-class diagram that models a university library's IT-system. A full credit solution must have the following properties:

- Book titles shall have title attribute and a number representing the title's edition.
- A book title can have 1 or more authors. The order of authors is significant.
- Information shall be stored about the date when each book item (each physical book) was bought. The library can have more than one book item of each title.
- Each book item is either stored in a book shelf at the library or borrowed by one of the library's customers. Each shelf has a unique number.
- A customer is either an employee of the university or a student. Both employees and students can borrow books. The system shall keep track of which books they have borrowed.
- Names and personal number shall be available for all customers. Moreover, employee's employee number shall be saved and for students their student id number shall be stored.
- Some employees have written books that are available in the library. The system shall keep track of which books an employee has written.

(4)

### **Area 3: Testing**

**3a)** Which of the following statements are true? Answer with the statement number only. No motivation is needed. (2)

1. Typically, during performance testing all functional requirements are tested.
2. In unit testing, units can for example be classes, functions, or methods.
3. In the ideal scenario, the customer is writing, conducting, and evaluating the acceptance test.
4. By computing the cyclomatic complexity using formula  $V(G) = E - N + 2P$  we get a number that states the number of branches that needs to be tested to get full branch coverage.

**3b)** Explain what integration testing means and how the two approaches of bottom-up and top-down differs. Do not forget to explain how stubs and drivers are used in the above approaches. (4)

**3c)** Give a brief overview of different documents and files that can be used for planning and performing tests in a software project. Both manual and automatic testing should be considered. (4)

### **Area 4: Planning and Processes**

**4a)** Which of the following statements are true? Answer with the statement number only. No motivation is needed. (2)

1. By computing the critical path in a project plan, it is possible to see if and how much an activity can be delayed without delaying the whole project.
2. The product backlog in Scrum contains product backlog items (PBIs) that are prioritized once during the first iteration in a products lifetime.
3. A project plan can for example contain sections about project description, risk management, milestones, deliverables, and project organization.
4. Defining a contingency plan is a good way to lower the probability of a risk event to occur.

**4b)** Answer each of the following questions shortly and concisely (1-3 sentences):

- What is Time-boxing and why is it/is it not used in a classic waterfall process?
- Which roles exist in Scrum?
- Which aspects are important to consider when prioritizing requirements?
- In which RUP phase are typically prototypes developed and evaluated. (4)

**4c)** Effort estimation in software engineering projects is hard. Give at least two reasons for why it is hard in practice. Give the name of one algorithmic method and one expert judgment method for effort estimation and explain one of them. (4)

## **Area 5: Quality factors**

**5a)** Which of the following statements are true? Answer with the statement number only. No motivation is needed. (2)

1. The reliability of a system is estimated to the average time between failures in operation and is measured in number of faults per hour execution time.
2. The maximum depth of the inheritance tree can be a negative indicator of program understandability since it can be hard to determine how a change in a class higher up in the hierarchy will affect inherited or overridden methods of low-level classes.
3. The cyclomatic complexity,  $V(G)$ , of a program is a negative indicator of how easy it is to change a program since people will have a difficulty determining the behaviour of a program with many branches.
4. The defect detection rate of a software review is calculated as the total number of unique defects found divided by the time spent in constructing the reviewed document.

**5 b)** Your company had been very successful with innovative technical solutions and are now ready to grow both in personnel, customer base, and complexity of products. At a company meeting you came to the conclusion that the project planning and management is not always the best. You write a project plan according to what you have learnt in school, but when projects become longer no one cares about the plan any longer. First there is a stage when you write down changes of the plan weekly in separate document. However, after a few weeks it is the project leader who knows the plan. No documents are written anymore.

Now you have read about CMMI and will suggest *four* different process areas from level 2 or 3 which your company shall work with in order to mature in project planning and management. For each of the process areas, provide a motivation in 1-2 sentences of why this area can help you. (4)

**5 c)** For each of the review variants Inspection, Walk-through, Management review, and Audit; write down 1-2 sentences describing the review variant so that it is possible to determine what the *differences* between the variants are. (It is, for instance, not sufficient to write “the goal is to improve quality” for every variant.) (4)

## Part 2: Advanced

6) Imagine that you are working as a configuration manager (CM) at the R&D department in a software company. Besides you, 6 software developers and 2 testers are working at the department. The company is developing a client-server product, where the clients are developed in language C and the server in Java.

Your task is to write down a clear plan for the configuration management strategy of the department. The strategy should be written down and explained concisely in a document, where the following items should be covered:

- Continuous integration should be used. Make sure to describe clearly how the developer should work. Describing the workflow is a good approach.
- A centralized modify-merge SCM approach should be used. Suggest a version handling system that can be used and describe the main structure of the repository. It should include the use of branches, trunk, and tags.
- An automatic build, test, and integration system should be used. Describe a process of how programs and results should be compiled, tested, and reported. Do not forget to explain how you intend to handle different versions of the product.

The expected readers of the document are the developers and testers at your department. Hence, it should be hands-on and concrete so that they understand how they should do their job. (20)

7) According to Wikipedia 2010-01-10 a Social service<sup>1</sup>:

“... focuses on building and reflecting of social networks or social relations among people, e.g., who share interests and/or activities. A social network service essentially consists of a representation of each user (often a profile), his/her social links, and a variety of additional services. Most social network services are web based and provides means for users to interact over the internet, such as e-mail and instant messaging. Although online community services are sometimes considered as a social network service in a broader sense, social network service usually means an individual-centered service whereas online community services are group-centered.

The main types of social networking services are those which contain category divisions (such as former school-year or classmates), means to connect with friends (usually with self-description pages) and a recommendation system linked to trust. Popular methods now combine many of these, with Facebook, Bebo and Twitter widely used worldwide; ...”

A Social service, in this sense is critically dependent on properly working software, and in this problem we assume that you are working in a software provider company.

- a) Write 8 functional requirements and 2 non-functional requirements for a Social service. The non-functional requirements shall not be usability requirements. You may chose to specify a part of a Social service or write requirements on high level for the entire service. The important thing is that the functional requirements are on *the same* abstraction level.

Motivate in 3-4 sentences why you think that your requirements are good requirements. We assume that they will be part of a requirements specification for the entire Social service. The requirements need not to be perfect, the important thing is that you bring forward some good properties. (10)

---

<sup>1</sup> Note that references or quoting from Wikipedia is not generally recommended in academic thesis work. This quotation is only used for giving you a hint about what a social service can be and should not be considered as the truth about social services.



b) Create a UML Sequence diagram for sending a virtual gift to a person. Person A can buy a virtual gift, pay with credit card and send the gift to Person B. When Person B receives the gift, it is written in the profile of Person B and a notifying mail is sent to Person B's mail. The sequence diagram shall describe communication between at least 6 roles (also called participants). The following list are examples of roles that you can use:

- : A (Actor)
- : B (Actor)
- : Web-server (A)
- : Web-server (B)
- : Profile (A)
- : Profile (B)
- : Social network server
- : Gift server
- : Web-browser (A)
- : Web-browser (B)
- : Payment server
- : Incoming mail server (B) (10)

c) The usability of a Social networks is important. Your task is to propose a usability metric consisting of a linear combination of 2 different measurements. Your answer shall contain:

- Two measures that can be related to usability
- For each of the four measures motivate why they are related to usability
- Give weighted factors for the measurements, and motivate why you selected the particular factor.
- Create a plan for how you can obtain the measurements for a new release of the Social service. A plan contains how you measure your variables, what type of resources you need, and in which order different things are done. (10)