

Written exam for Software Engineering Theory

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!

Kristian and David

Problems

Part 1: Fundamental

Area 1: Requirements

1 a) Consider the following requirements for a student portal:

R1: The system shall have high capacity.

R2: The system shall serve at least 100 000 students, where 50 students can be logged into the portal simultaneously, with a maximum response time of 2 seconds.

R3: The students shall be able to sign up for courses for the next semester.

R4: If the students sign up for more than 45 credits per semester, an error message is displayed informing the student that 45 credits is the maximum number per semester.

R5: If the students sign up for more than 45 credits per semester, the following error message is displayed: "You are only allowed to sign up for 0-45 credits per semester".

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

1. **R1** and **R2** are inconsistent non-functional requirements.
2. **R2** is a testable non-functional requirement,
3. **R5** is possible to test automatically whereas **R4** needs a human tester
4. **R3** mentions ability and is thus a non-functional requirement

1 b) Draw a use-case diagram consisting of four use-cases and two different actors for a university library system. One of the use-cases shall have a detailed description that shall contain one sentence for the initiation of the use-case and one sentence for the termination. At least four sentences shall describe the flow of events. (4)

1 c) Good requirements shall have many properties fulfilled. Explain the meaning of the following properties: *Inspected*, *Unambiguous*, *Traceable*, and *Feasible*. (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 divide-and-conquer strategy to design means that you divide the design task to several teams, and select the most competitive solution.
2. A system with high coupling is a mature, well-maintained product where all modules form a unity.
3. A well-designed system has both high cohesion within modules and low coupling between modules.
4. The process of designing an architecture can involve both throw-away prototyping and evolutionary prototyping for the same system.

2 b) Explain shortly and concisely the idea and main concepts of the layered architecture style. Explain with examples at least one advantage and one drawback of the style. (4)

2 c) Draw an UML class diagram that models the manager structure at IDA:

- Teachers are either Full Professors, Associate Professors, or Assistant Professors.
- PhD students must have a main advisor.
- The main advisor must be either Full Professor or Associate Professor.
- A PhD student might have a primary advisor, who is Assistant Professor
- A PhD student must have at least one secondary advisor.
- Any teacher can serve as secondary advisor.

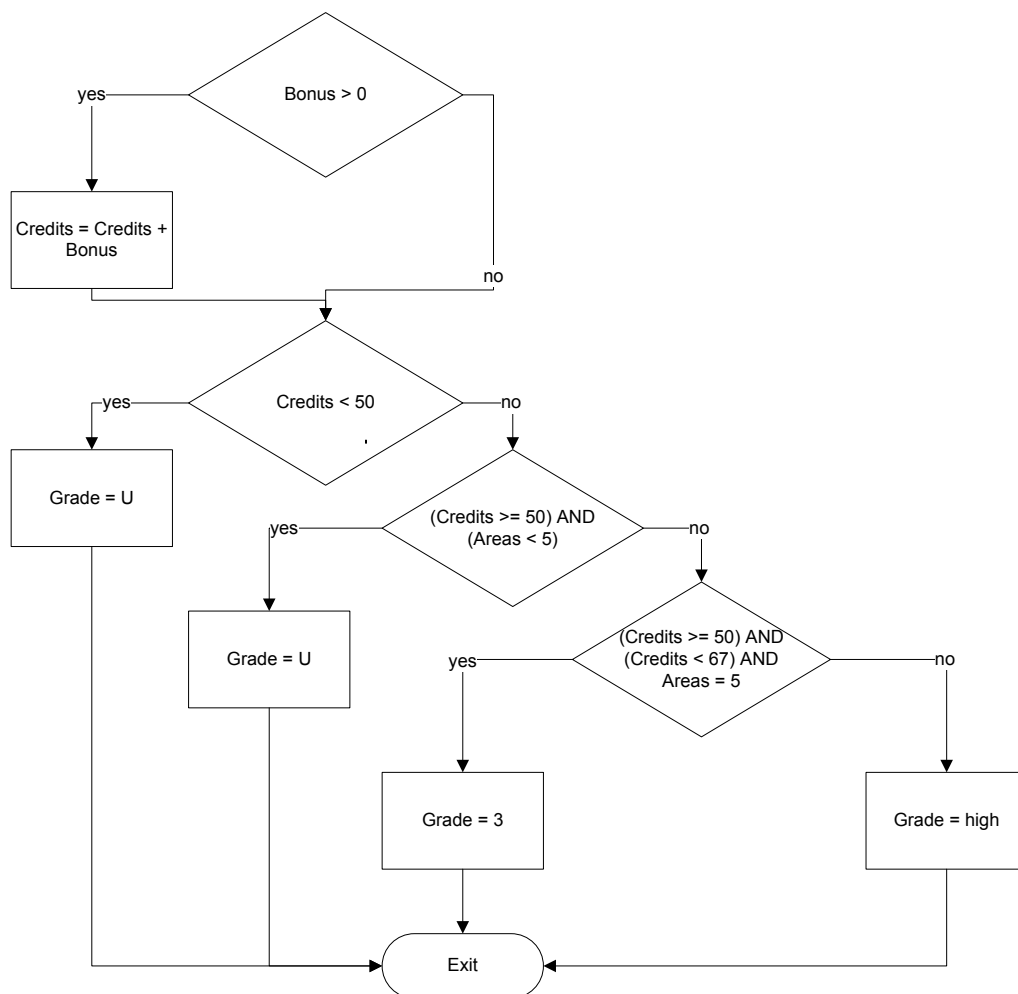
(4)

Area 3: Testing

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

1. An oracle can either be a human or a program determining whether the result of a test gave the expected result or not.
2. A rule in a decision table can be easily converted to a test case by assigning a set of values for the input variables such that the conditions of the rule are satisfied.
3. Exhaustive testing is a process where you stop testing when your testing resources are finished.
4. In software terminology, a failure is committed by a human programmer, that results in an error of the program.

3b) Consider the following flowgraph.



Write down two sets of test cases. The first set shall ensure statement coverage with a minimum number of test cases. The second set shall ensure path coverage with a minimum number of test cases. (4)

3c) Explain the terms in integration testing: Top-down strategy, Bottom-up strategy, Big-bang strategy, and Sandwich strategy. (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. A stakeholder of a project is a person or organization with an interest in the project outcome.
2. The real time it takes to fulfil a task is the available time plus the slack time.
3. A toll-gate is about deciding the future of a project, whereas a mile-stone is to check the fulfilment of goals.
4. A Gantt-chart is a map of all major functions and their most important interdependencies of a product.

4b) Explain with a short example: Risk avoidance, Risk transfer, Risk mitigation, and Risk planning with a Contingency plan (4)

4c) Describe one Role, one List and two types of Meetings in SCRUM.(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 lines of code for two functionally identical programs implemented in different languages are almost the same, since verbose languages require very few comment lines.
2. Many real-life and academic studies observe that modules with a high number of lines of code tend to have a high density of defects.
3. The cyclomatic complexity $V(G)$ can be calculated as the number of binary decisions in a program flowgraph.
4. Many handbooks advises you to sub-divide your code so that you have low cyclomatic complexity per module. McCabe himself thought that an upper limit of 10 is acceptable¹.

5 b) Shortly describe (1-2 sentences) the CMMI level 2 process areas Requirements Management and Project Planning. Write down a difference between Requirements Management and level 3 process area Requirements Development. Write down a difference between Project Planning and level 3 process area Integrated Process Management.(4)

5 c) Inspections are a powerful variant of software reviews, but every success comes with a cost. Give two potential problems or cost drivers with inspection, and write down a suggestion of how their impact can be lowered. (4)

¹ Hint: The number 10 is correct, but was it an upper or lower limit?

Part 2: Advanced

6) Imagine that you are a software architect working for a web-version of a newspaper. It is a mixed content; some of the articles are editorial material that is written with afterthought and research. Other articles are brief reports that are sent in by mail or SMS by field journalists covering, for instance, a severe accident. Typically these news are continually updated as more knowledge is collected. A third category of articles are imported from new agencies, such as Associate Press, covering many countries. Everything that is published has to be approved by the legally responsible editor. The web page and links are handled by a web-layout editor. The readers can participate by providing comments to the articles, via a form that assures that the reader is a physical person. A special editor makes sure that no offensive comments are visible.

In the solutions to the problems below, you may make additional assumptions; these shall be clearly accounted for.

- a) Create 3 different detailed uses-cases involving at least two different actors. Draw one use case diagram, which gives an outline of the use-cases. Do not forget the system boundary. (5)
- b) Write two different non-functional quality requirements. Carefully explain how each requirement can be measured. (6)
- c) Draw a UML activity diagram describing the flow of events for covering a severe accident. The news are updated several times, and readers share their feelings about the accident. The reader comments shall follow the entire collection of updated reports about the accident; not a set of comments for each update. The activity starts when the journalist has formulated his/her first report and ends when no further updates or reader comments are made.(4)
- d) Draw a UML state-diagram of an article. Use at least 5 states. Typical states are: created, inspected, refused, updated, published and archived. (5)
- e) Draw a deployment diagram of some major components of the system. Use at least five nodes. Typical nodes are: Different portable equipment, different editorial workstation, hosts for web-servers, and data-bases, etc. (5)
- f) Write down five functional test cases of a part of the system. Don' t forget to write a sentence explaining the major intention of the sub-system you are dealing with. (5)

7) You are in a leading position of a software house developing support systems for support personnel. Your system allows for managing knowledge about consumer electronics including computers and common software. The users work at a support centre and receive calls from customers with problems. Through advanced search, the support person retrieves explanations and instructions, and can also consult with colleagues via intranet. The user can also input new problems and solutions to the system. It can sometimes become stressful when customers call with complicated problems and are disappointed about their purchase.

The recent years has seen a significant drop in user satisfaction. The products in the support centre have been more complicated, and your usability expert retired 4 years ago at the age at 70, so you cannot ask her to come back. Your personnel are technically skilled, you use some standard tools, such as, Eclipse, and you use an incremental development method with two releases per year. You are rated on CMMI level 2.

Your task is now to make a boost in usability. List at least 10 different things that you need to bring to the attention of your personnel. The list comprises many things such as, development methods, processes, roles, measurements, tools, organization, company values, etc. For each item on the list, make a short description and a motivation to why it can contribute to good usability.(20)