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:

<table>
<thead>
<tr>
<th>Number of correct statements in the answer</th>
<th>Number of incorrect statements in the answer</th>
<th>Number of credits</th>
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<tbody>
<tr>
<td>2</td>
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**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:

<table>
<thead>
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<th>Total credits</th>
<th>Mark in Swedish system</th>
<th>Translation to ECTS</th>
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<td>5</td>
<td>A</td>
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<tr>
<td>83-67</td>
<td>4</td>
<td>B</td>
</tr>
<tr>
<td>66-50</td>
<td>3</td>
<td>C</td>
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<tr>
<td>49-0</td>
<td>UK</td>
<td>Fx</td>
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*Good Luck!*  

*David and Kristian*
Problems

Part 1: Fundamental

Area 1: Requirements

1 a) Consider the following requirements for a fantasy game:

- **R1**: If a player reaches skill level 10 or higher and plays with character “Orch” then the player’s power level shall be set to “Advanced”.
- **R2**: All players playing on power level “Advanced” must be playing with a character that is on the good side.
- **R3**: The characters on the good side can only be “Human” or “Hobbit” or “Elf”.
- **R4**: In the off-line mode skill levels must be updated within a second after the most recent fight is won.
- **R5**: The availability of the on-line game server must be very high, except on Wednesdays between 10 and 12 Greenwich Mean Time.

Which of the following statements are true? Answer with the statement number only.

No motivation is needed. (2)
1. R1 and R2 are inconsistent.
2. R1 and R2 and R3 are inconsistent.
3. R1 is a functional requirement and R5 is a testable non-functional requirement.
4. R4 is a non-functional usability requirement that can be tested by the programmers themselves.

1 b) Create one use case with two actors for a Course portal, such as It’s Learning or Blackboard. From the use-case, derive and write down 2 functional requirements and one non-functional requirement. (4)

1 c) Write four good properties of a requirements specification written in natural language. For each property, provide an explanation of its meaning and explain a negative consequence if the requirements specification is not having the property. The following is an example of the solution for one property:

**Property:** All requirements are numbered.

**Explanation:** All requirements are assigned a unique number or a unique label.

**Consequence if not present:** It will be hard to discuss changes of the individual requirements if the requirements are not easily identified.

Note that you are of course not allowed to use this example in your solution. (4)
Area 2: Design and Architecture

2a) Consider the following UML-diagrams:

![Diagram 1]

Diagram 1

![Diagram 2]

Diagram 2

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

1. The object diagram in Diagram 2 describes a possible instance structure of the class diagram in Diagram 1.
2. The association between VisualComponent and Picture ending with a filled diamond in Diagram 1 is a composition, which indicates that a certain instance of Line can only belong to one certain instance of Picture.
3. From Diagram 1 it would be possible to create an instance of Rectangle composed by 4 instances of Line.
4. Diagram 1 shows an example of how to use the Facade design pattern.
2 b) Create 3 different diagrams for 3 different architectural views of a text chat messaging system that contains the following unsorted elements:

- Linux Server (Dell hardware)
- GUI library (Java)
- Client
- Objective-C main module.
- GUI library (Objective-C)
- Windows Laptop
- Chat protocol lib (Objective-C)
- IPhone (hardware and OS)
- Java client main module.
- DBMS access library (Java)
- Chat protocol lib (Java)
- Java server main module.
- Server
- Database Mgm. System (DBMS)

The Architecture style is a two-tier fat-client solution. Language Objective-C is used on the IPhone platform and Java on the Windows laptop and Linux server. Write out clearly what the views are called and give a short motivation and description for each of the views (4).

2 c) Kristian’s alarm clock starts sounding at 6.00 with a nasty signal. He can now do either of three things: a) Turn the alarm off; b) Press the snooze button; or c) Do nothing. If the snooze button is pressed the signal will turn off and start sounding after 5 minutes again. When an hour has passed from the first time the alarm sound started, the snooze button has no effect. After that the alarm sound starts, the signal will last for 2 minutes. If no action has been taken during these 2 minutes, the absence of action will have the same effect as if the snooze button were pressed exactly when the alarm stopped to sound.

This was a wordy design description; your task is to clarify the meaning by drawing a UML diagram to describe the behaviour of the alarm clock. Write down the name of the type of UML diagram you have written, and give a single argument for why you chose that particular type of UML diagram for this task.(4)

**Area 3: Testing**

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

1. Regression testing means that we use linear regression to calculate the curve of reliability growth in order to determine when to stop testing.
2. Top-down integration testing implies that you have to write many drivers.
3. Bottom-up integration testing can be performed before all code is written.
4. In performance test you can test requirements on system reliability.

3b) Create a control flow graph, where the minimal number of test cases for branch coverage is different from the minimal number of test cases for path coverage. Don’t forget to motivate why there is a difference between the minimal number of test cases. Calculate the cyclomatic complexity of your flow graph. (4)

3c) Explain the terms: installation testing, system testing, alpha testing, and beta testing. (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. The main problem with the Spiral model is the lack of handling risks.
2. Effort estimation in Scrum is using a variant of the Delphi-method, which is based on expert judgements.
3. Automated build and continuous integration depend on each other in such a way that it is not possible to make use of automated build without having continuous integration.
4. One key difference between using the waterfall model compared to iterative process models with time-boxing is that projects using the waterfall model typically get delayed if not all requirements are fulfilled at a deadline. However, with time-boxing, delivery occurs on time, even if not all requirements are met.

4b) Create a short risk management plan for a software development project (you can make up any software project you like – as long as it is making legal software…). The plan should include one technology risk, one people risk, and one tool risk. The risk analysis should include probability, impact, and risk magnitude indicator. There are two strategies for accepting a risk. For each of the 3 risks, write down one example for each strategy. (4)

4c) Draw a GANTT chart for a software project that is following the RUP or OpenUP process. Create at least two activities for each phase according to the process. Decide two milestones and one tollgate in the project. Give a short description explaining the different parts of the GANTT chart. (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. To implement Total Quality Management it is important that you can trace every software item to the individual programmer, so they can be personally accountable for good and bad things in their software.
2. If you are positively evaluated by a TickIT auditor you fulfil many of the requirements for ISO 9001.
3. Quality function deployment means that you take decision on which hardware you deploy the most critical functions of the software.
4. CMMI and its forerunner CMM became widely accepted since the US Department of Defence made a policy not to buy software from organisations rated below level 3.

5 b) Verification and Validation are two process areas at CMMI level 3. For both of these areas provide a) a definition; and b) a description of how you can fulfil the area in your testing activities. The definitions shall be clear enough so the reader can determine the difference between Verification and Validation. (4)

5 c) Describe two different software metrics which measure the same quality factor. Don’t forget the motivation and the description of how to obtain the numerical values. (4)
Part 2: Advanced

6) Create a checklist for inspectors of a document or code. Describe which type of document or code that the checklist applies to. The checklist shall comprise at least five items. For each of the items provide:

- The checklist question, which shall be answered “yes” when it is completed.
- A motivation of which type of common mistake or defect that the checklist item can help the inspector to discover.

Example: If I decided to write a checklist for a requirements specification an item might be:

- **Question**: Are all requirements uniquely numbered?
- **Motivation**: This prevents forgetting requirements when prioritising them and planning for implementation.

Hint: Make sure that your checklist items are specific, measurable, and relevant, so the inspector can tick them off with no hesitation. General items, such as: “Is the implementation method sound” will neither be of much help, nor give any credits.

(10)

7) Imagine that you are a software architect working for a fairly large on-line book store (1 million active customers). The customers can look at books online using a standard web-browser, select what they want to buy, and pay using credit cards directly on the website. Your business model is very cost effective, since you do not have a book warehouse. Instead, when a customer purchases a book, your system automatically places an order on your suppliers system (book publishers) and then the books are shipped directly to the customer.

   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) You are currently using a two-tier client-server architecture. However, you are facing scalability problems with this architecture. You are now looking into changing your architecture to something that is based on service oriented architecture (SOA). Describe how SOA can help you solve the problems with the two-tier architecture and explain how it can also give you new business opportunities. Give a high-level non-technical description, that even your managers would understand. (5)

   c) Draw an activity diagram describing the order-deliver process (i.e. from that the user “searchers for books” until “the book arrives in the customers mailbox”). The solution must contain at least 6 activities, 1 fork, and 1 branch (decision point). (5)

   d) Draw a sequence diagram for the two-tier architecture, illustrating the interaction between the participants: client’s web-browser, the web-server, the database management system (DBMS), the suppliers’ servers for warehouse status, and the bank’s systems for credit card payment. All interacting participants must send or receive at least one message. The sequence diagram must illustrate a realistic scenario. (5)
8) You are a newly hired R&D manager for a small software development company that sells embedded software for the retail market. Your main products are software that are placed in personal digital assistants (PDA:s) (for scanning inventories) and point-of-sales (POS) systems (the main system that the shop assistants are using when helping a customer). Currently, the company is using a development process that is similar to the classic waterfall model. The company do not have any tool support in their development except standard text editors, compilers, and a file server. There are 10 employees in the company:

- 1 CEO
- 2 Sales persons
- 1 Marketing manager
- 1 Project manager
- 2 testers
- 3 developers

Your task is to write down an e-mail to the CEO of the company, where you argue for that the company should change their way of working. Assume that the CEO is mostly familiar with traditional project management, and that you suggest them to use a variant of Scrum, together with some useful agile practices. Make sure that you explain each concept carefully so that she understands why this is useful/not useful and how it might be implemented in the organization. Below, you will find a list of concepts and topics for which you are supposed to argue either for or against.

- Sprint
- Time-boxing
- GANTT-chart
- Product and project manager
- Waterfall model
- Self-organization
- Burn-down chart
- Product Backlog
- Continuous Integration
- Configuration Management
- Automatic Build
- Planning Poker
- MS Project
- COCOMO II
- Refactoring
- Unit-testing
- System testing (automated)
- Scrum Roles
- Sprint planning and review
- Impediment list

Please note that your email should be an arguing and convincing e-mail, not just a list of statements. (20)