# EXAM FOR INFOTECH

## Software Engineering for Real-Time Systems

**WT 11/12**

<table>
<thead>
<tr>
<th>Name:</th>
<th>Matriculation No.:</th>
<th>Grade:</th>
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</table>

**Exam day:** 13.03.2012  
**Exam length:** 120 minutes  
**Exam extent:** 4 tasks (8 pages)  
**Aids allowed:** All, except for programmable electronic devices and communication devices.

**Notes:**  
1.) All tasks are required.  
2.) Don’t use red pencils or pens.  
3.) Put down your name and matriculation no. in the box.  
4.) Use a separate sheet of paper for every task.  
5.) References to script pages or exercise tasks are not evaluated  
6.) Hand in this cover with your solutions.  
7.) Be sure that your name is written on each sheet handed in.

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Not to be filled out by the student

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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</table>
Task 1: Analysis and Design (approx. 30 min)

You are working for a company as a software engineer, the company produces different types of digital cameras. The company wants to introduce a new type of digital camera to the market. The new type would provide new functionalities like saving the photos to a cloud. The new camera will have the same old software for the photo shooting functionality, while a new software has to be developed for the new functionalities. Your project manager entrusted you with the analysis and the design of the software of the new camera. The software has to send photos directly to the specified cloud using a WLAN component, in addition the camera will have an integrated GPS component.

The software has to provide the following functionalities:

- **Storing photos in a cloud:**
  The software has to be able to store the photos in a specified cloud, the user can specify one or more clouds he wants to use. When saving photos, the default cloud for the user will be used unless a different one was selected by the user before saving. After selecting the cloud, an internet connection will be set up and the data will be transferred. For each photo, photo-ID, the current date and the location will be saved as well as the photo itself. For each user an album will be created in the selected cloud where his photos are saved.

- **Browsing photos:**
  The user can browse the saved photos on the cloud. The album of a user can be accessed by anyone if it is not protected by a password. If a password is required to show pictures, the password should be specified by creating the album and saving photos into it for the first time.

- **Sharing photos:**
  The user has the possibility to share a selected set of photos directly from the camera to any social network (like facebook or twitter). In this case the user information (username and password) is needed to login to the selected social network and push the photo and its information to it, these information will be stored for every user and can be directly sent to the social network when login is required.
Hints:

- Model all necessary storages.

**Question 1.1: Context Diagram**

Draw the context diagram using the „Structured Analysis (SA)“ method for the software depicted above.

**Question 1.2: Data Flow Diagram Level 0**

Draw the data flow diagram for level 0 using the “Structured Analysis (SA)” method. Consider all described functions of the new software.

**Question 1.3: Refinement of the sub-process „Storeing Photos in a cloud“**

Draw a data flow diagram using the method “Structured Analysis (SA)” that refines the sub-process “Storing photos in a cloud”.

**Question 1.4: Data Dictionary**

Specify all data in a data dictionary.
**Task 2: Basics and Test (approx. 20 min)**

During the development of an online shop, a database for managing the required data has to be created. Every online order has 2 sets of data, the first set is about customer information and the second set is about the order positions. Each order might have max. 200 order positions. The customer information includes the name, the postal address, the dispatch address, the e-mail and the bank information of the customer. For each order position, the ordered article and the ordered quantity are included. For each article, the article number, the stock, the storage information and the price should be saved. The storage information in turn consists of the information of the shelf row, the column, and the shelf line.

**Question 2.1: ER-Diagram**

Create the Entity Relationship diagram for the needed information.

As a next step, you should test a partial function of the software. The function is shown in Listing 1. The sort () function is used to sort the articles by article number in ascending or descending order. The parameter direction in this case indicates the sort order. For ascending order, the parameter is set to 1, in descending order, the parameter is set to -1.

The method length (list) returns the number of elements in the passed list. The operator [i] is used to access the i-th element of the list. The first element of the index i = 0, (list [0] returns the first element, list [length (list) - 1] gives the last element). The method swap (list a, b) interchanged the a-th and b-th element in the passed list.

```java
void sort(list, direction){
    n = length(list);
    inverted = true;
    while(inverted AND n > 1){
        inverted = false;
        for(int i = 0; i < n-1; i++){
            if(direction > 0){
                if(list[i] > list[i + 1]) {
                    swap (list, i, i + 1);
                    inverted = true;
                }
            } else{
                if(list[i] < list[i + 1]){
                    swap (list, i, i + 1);
                    inverted = true;
                }
            }
        }
        n = n - 1;
    }
}
```

**Listing 1: Sort Function in Pseudo code**
Question 2.2: Control Flow Diagram

Draw the control flow diagram for the given function.

Question 2.3: Test Cases

Create test cases that can give 100% C1 coverage. Assume that the list consists of integer values.
Task 3: Project Management (approx. 30 min)

You are working for a software company as a project manager. The company has got the job, to develop a software for tickets sales for the upcoming London Olympic Games.

You, as an expert in project management, were chosen to work on this project. After the kickoff meeting with the project staff you were able to identify the following work packages (WP):

<table>
<thead>
<tr>
<th>WP</th>
<th>Activities</th>
<th>Duration (M)</th>
<th>Previous activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Market analysis</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>B</td>
<td>Requirements definition based on the analysis results</td>
<td>6</td>
<td>A</td>
</tr>
<tr>
<td>C</td>
<td>Rough draft of the operating concept</td>
<td>7</td>
<td>B</td>
</tr>
<tr>
<td>D</td>
<td>Analysis of the requirements of the organizer</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>E</td>
<td>Design of the ticket allocation algorithm</td>
<td>10</td>
<td>D</td>
</tr>
<tr>
<td>F</td>
<td>Interface design for Payment Systems</td>
<td>8</td>
<td>D</td>
</tr>
<tr>
<td>G</td>
<td>Implementation of the user interface</td>
<td>5</td>
<td>C, F</td>
</tr>
<tr>
<td>H</td>
<td>Implementation of the ticket allocation algorithm</td>
<td>14</td>
<td>E</td>
</tr>
<tr>
<td>I</td>
<td>Testing of the ticket allocation algorithm</td>
<td>7</td>
<td>H</td>
</tr>
<tr>
<td>J</td>
<td>Integration and testing of the payment functions</td>
<td>3</td>
<td>F, I</td>
</tr>
<tr>
<td>K</td>
<td>Beta testing for fine adjustment of the interfaces</td>
<td>3</td>
<td>G</td>
</tr>
<tr>
<td>L</td>
<td>Final integration and acceptance</td>
<td>6</td>
<td>J, K</td>
</tr>
</tbody>
</table>

Table 1: Work Packages

The software must be embedded in many different existing systems, such as the server of the organizer and has also to fit over the ports of the respective providers in the payment systems. A preliminary estimate shows that the project will comprise a total of 100,000 lines of source code. From previous experience the effort distribution can be estimated, Table 2 shows the distribution matrix for this project:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Phase</th>
<th>Analysis</th>
<th>Design</th>
<th>Implementation</th>
<th>Integration and Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysing</td>
<td>10%</td>
<td>20%</td>
<td>50%</td>
<td>10%</td>
<td>40%</td>
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<tr>
<td>Designing</td>
<td>60%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>40%</td>
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<tr>
<td>Programming</td>
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<td>60%</td>
<td>10%</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Testing</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
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Table 2: Effort Distribution
Question 3.1: Net Plan

Draw a net plan in critical path method (CPM) for the working packages and their predecessors given and identify the critical path. Use dummy tasks only if they are mandatorily required.

Question 3.2: Effort Estimation

Calculate the total effort for the project in person months using the constructive cost model method COCOMO. Calculate also the effort for the different project phases using the effort distribution matrix in Table 2.

Hint:
Round the total effort reasonably to a natural number of person months

Question 3.3: Metra Potential Method

Draw a net plan using the Metra Potential Method. What is the difference between both methods?
Task 4: Questions (approx. 40 min)

**Question 4.1:**

Explain the 90%-complete syndrome in a project. Describe two tracking and oversight mechanisms that give you early insight into project progress.

**Question 4.2:**

Selecting critical code components within the complete source code helps in focusing inspection efforts and thus improving efficiency and effectiveness of early defect removal activities. Explain five examples of source code where you would focus inspections.

**Question 4.3:**

How do you measure efficiency and effectiveness of test? Explain one approach to improve efficiency and another approach to improve effectiveness of test?

**Question 4.4:**

Name the major requirements engineering activities. Briefly explain for each what it is for.

**Question 4.5:**

What is a “profile” in UML and what is it used for? Provide two examples of profiles which we have discussed in the lecture.

**Question 4.6:**

What is the typical defect removal effectiveness in percent for design and code inspections and for manual testing?

**Question 4.7**

What is the meaning of FTA and where is it used?

**Question 4.8**

What are the four key priorities in the agile manifesto? Please explain for each, how it could harm in the development of safety-critical embedded real-time software.