

# CHALMERS

## EXAMINATION / TENTAMEN

Course code/kurskod	Course name/kursnamn		
Anonymous code Anonym kod	Examination date Tentamensdatum	Number of pages Antal blad	Grade Betyg
DIT636	Software Quality and Testing	16	5
DIT636 - RTT - HEC	2025-03-19		

\* I confirm that I've no mobile or other similar electronic equipment available during the examination.  
 Jag intygar att jag inte har mobiltelefon eller annan liknande elektronisk utrustning tillgänglig under  
 eximinationen.

Solved task Behandlade uppgifter		Points per task Poäng på uppgiften	Observe: Areas with bold contour are to completed by the teacher. Anmärkning: Rutor inom bred kontur ifylls av lärare.
No/nr			
1	X	7	
2	X	9	
3	X	8	
4	X	12	
5	X	8	
6	X	8	
7	X	11	
8	X	12	
9	X	13	
10			
11			
12			
13			
14			
15			
16			
17			
Bonus poäng			
Total examination points Summa poäng på tentamen	88		

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Question 1

1) b, c

2) 6

3) a

4) a

5) ~~c~~ -2

6) ~~a~~ -1

7) a (reliability)

I think that it is important for a pedestrian detection system to be correct (align with the specification) at a high rate and ~~not~~ have as little faults as possible (reliability focuses on those values) over being fast or scale well (scalability does not really make sense in such software).

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Question 2

### Reliability Scenario

Overview: The driver is warned when there is an obstacle in the path of the vehicle.

System state: the system operates normally ✓

System environment: all hardware components are working correctly and responding to inputs ✓

External stimulus: after a sharp turn, a medium-sized boulder appears in the path of the vehicle ✓

Required system response: the camera-based object detection system detects the obstacle on the road, display a warning message on the cockpit's screen, and plays a short sound to indicate the obstacle presence ✓

Response measure: the POFOD of the camera-based object detection ~~is kept below~~ warning functionality is below 0.005. ✓

5 p

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## Availability Scenario

Overview: One of the cameras used for the object detection fails/stops responding.

System state: the system is operating normally ✓

System environment: all hardware is working as expected and responds to inputs ✓

External stimulus: one of the cameras stops responding and providing information about the vehicle's area ✓

Required System Response: the system validates the lack of communication with the camera by sending pinging it ~~at~~ eight times in two seconds, if the communication is not back the component is restarted. If the restart did not fix the issue, a warning/fault notification is displayed on the ~~dashboard~~ dashboard indicating a problem with the camera. (4p)

Response measure: the system detects the fault in less than 2 seconds by using pinging the component. The component is then restarted and checked again in less than 3 seconds. The driver is notified about the broken camera in less than 100 ms. Therefore, the camera component failure is detected and the user notified in less than 5.1 s. Too many measures - also, will they be fulfilled in 100% of cases?

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### Question 3

#### Integration testing

The base of the integration testing is to make sure that individual components/units of the system can produce expected output and work correctly when "put together".

Even though those individual units might work correctly. It is important to make sure that they can operate as a system together. Therefore, the integration testing is meant to find faults that would show that units are not compatible, but should be.

#### Exploratory testing

The exploratory testing is a high-level and more ad-hoc, on-the-fly way of testing the software. Those type of tests are conducted by a human tester that often "puts on a mask," before testing and then explores the software by looking for a specific set of problems.

The idea of exploratory testing is to test the software more from a perspective of a user (sometimes by utilizing user/customer journey maps). A tester starts opens the software and by using the UI/GUI

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### Question 3 (Continue)

clicks on particular features and makes sure that the software operates <sup>(or looks)</sup> as expected from the high-level.

Since exploratory testing is done ~~elsewhere~~ on a high level, the faults that are detected often indicate that certain features do not work as they should or that there are some problems in the presentation layer of the system.

General differences between integration and exploratory testing

#### Integration Testing

- testing on the code level
- tests are written and automated using frameworks like JUnit (in Java) <sup>for example</sup>
- the main goal is to make sure that parts of the system (units put together) work as expected

#### Exploratory Testing

- testing on the high level (often from the user perspective)
- conducted on by a human tester
- the main goal is to explore a system by interacting with the presentation layer, making sure that feature works correctly, validate interactions and <sup>ui</sup> revalidating

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Testing a system at each state

1. Unit tests - the smallest way of testing where individual components (functions/methods) are tested to make sure they produce a valid output given a set of different inputs. Unit tests take the majority of all tests.
2. Integration tests - testing if the units of a program work correctly when put together. The idea is to test a portion of a system.
3. Exploratory tests - ad-hoc/on-the-fly way of testing by a human-tester who by interacting with the presentation layer is looking for faults in features, problems with interactions or UI rendering issues
4. Acceptance testing / A/B Testing - software is given to the users in order to check if the software meets their requirements and solve their problems.

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Question 4

public String[] analyseObstacles (List<Float> cameraData)

parameters: cameraData

choice: Number of elements in the array

- 0 ✓
- 1
- 10
- 100 (single)
- 1000 (single)

choice: input type of array elements

- negative values (<0) [error] (if length >0)
- out of range values (> 2.0) (if length >0)
- in range values ( $\leq 2.0$ ) <sup>and > 0.0</sup> (if length >0)
- blocking the camera values (= 0.0) (if length >0)

Good! 12/12

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Question 5

1)

Guidebook tour - the Guidebook tour is a part of the Business district (focusing on the most important, core features) and is based on a tester going through manuals, guides, tutorials and checking how the software matches with those resources. If a mismatch is found a fault is reported. By using a Guidebook tour, a tester can validate both a software and the guide/tutorial material at the same time.

2)

2.1) Account registration

- ↳ navigate to the login page of the application
- ↳ click on „sign up“ at the bottom of the login form
- ↳ fill in your username, email, and password
- ↳ click „submit“ button to register a new account

The following interaction makes sure that a user can create a new account for the discussion forum

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### Question 5 (Continue)

#### 2.2) Edit your topic posts

↳ Log-in to the discussion forum

↳ Navigate to the „topics“ page by using the side navigation on the left side of the screen

↳ Click on „my topics“ icon in the top right corner of the „topics“ page

↳ Find the topic that contains a post that you would like to edit

↳ Find the post that you would like to edit

↳ Click on the „edit post“ icon in the top right corner

↳ Edit the content of the post and click „Save“ afterwards

The following interaction makes sure that a user can edit a topic the post that they already created

#### 2.3) Delete entire board (Administrator feature)

↳ Log-in to the discussion forum

↳ Navigate to the „boards“ page using the side navigation menu

↳ Click on „manage boards“ button in the top right corner of the page

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### Question 5 (continued)

↳ Select the checkbox of a board or multiple boards that should be deleted

↳ click on the delete icon in the top left corner of the page

↳ confirm the deletion

The following interaction makes sure that an administrator user can delete a board from the forum.

All the sequences that we've provided above were meant to "mimic" a ~~great~~ tutorial/guide like steps that would be followed by a tester during an exploratory session based on the guidebook too.

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**Question 6**1) **@Test**

```
public void testAnalyzeObstacles_normalUsageOneObstacle() {
    List<Float> cameraData = {2.5, 1.45};
```

```
String[] expectedResponse = {"1.45"};
```

```
String[] actualResponse = analyzeObstacles(cameraData);
```

**✓ goed**

```
assertEquals(expectedResponse.length(), actualResponse.length());
```

```
assertEquals(expectedResponse[0], actualResponse[0]);
```

3

2) **@Test**

```
public void testAnalyzeObstacles_normalUsageObstruction() {
```

```
List<Float> cameraData = {2.5, 0.0};
```

```
String[] expectedResponse = {"0.00"};
```

```
String[] actualResponse = analyzeObstacles(cameraData);
```

**✓**

```
assertEquals(expectedResponse.length(), actualResponse.length());
```

```
assertEquals(expectedResponse[0], actualResponse[0]);
```

3

3) **@Test**

```
public void testAnalyzeObstacles_negativeCameraData() {
```

**Throwable**

Exception exception = assertThrows(NegativeCameraData.class,

-1p.      () -> **you don't need to assign the**  
**list** `cameraData = {-5.0};` **output of**  
**analyzeObstacles(cameraData);** **assertThrows.**

3);

8/9

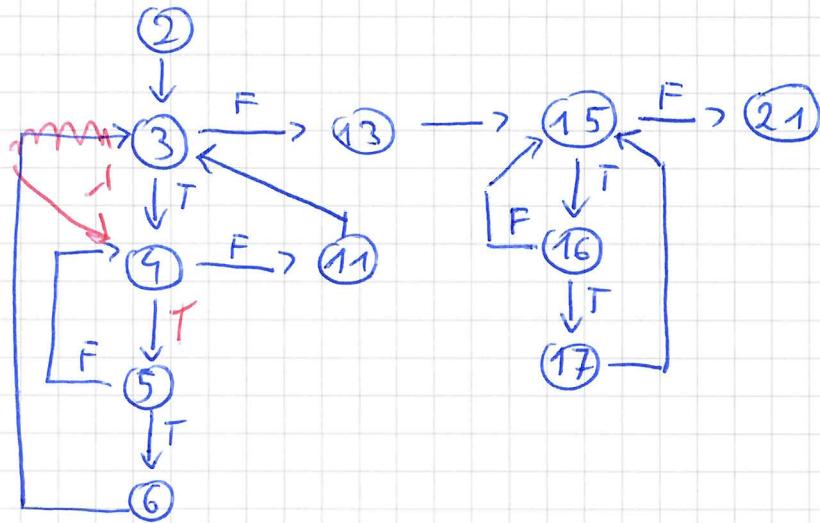
exception

Assuming that a „NegativeCameraData“ is thrown on negative input.

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		(11)	Question no. Uppgift nr <b>7</b>

## Question 7

1) 5



2)

Test Input: letters = [ „j” , „o” , „h” , „m” ]

word = „code”

statements covered: 2, 3, 4, 5, 6, 7, 8, 11, 13, 14,

15, 16, 17, 18, 21

branches covered: 3-T, 4-T, 5-F, 4-F, 5-T, 3-F,  
15-T, 16-T, 16-F, 15-F

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## Question 8

1)

variable	def	use
letters	1, 6	4, 5, 14, 15, 16, 17
word	1, 11	3, 5, 11
lettersRemoved	2, 7	7, 14
i <sub>1</sub>	9	4, 5, 6
idx	13, 18	17, 18
output	14, 17	21
i <sub>2</sub>	15	15, 16, 17

Pairs:

(1, 4), (1, 5), (1, 14), (1, 15), (1, 16), (1, 17)

(6, 9), (6, 5), (6, 14), (6, 15), (6, 16), (6, 12) ~~(6, 12)~~

(1, 3), (1, 5), (1, 11)

(11, 3), (11, 5), (11, 11)

(2, 7), (2, 14)

(7, 7), (7, 14)

(4, 4), (4, 5), (4, 6)

(13, 17), (13, 18)

(18, 17), (18, 18)

(14, 21), (17, 21)

(15, 15), (15, 16), (15, 17)

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Question 8 (continue)

- 2) The following input achieves all def-use pairs coverage:

letters = [,,a",,,b",,,c"]

word = „cde”

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Question 9

1) nov: 5, 6 ✓ (2p)

aov: 2, 5, 6, 9 ✓

cvp: 3, 5, 6, 2, 9

2) nov: line 5 mutation

for (int i = 1; i <= s.length() - 1; i++) ✓  
    ↖ mutant

aov: line 9 mutation

s6. append (" " + s.charAt(i) + - s.charAt(i) + s.charAt(i)); ✓  
    ↖ mutant

cvp: line 5 mutation

for (int i = 10; i < s.length() - 1; i++) ✓  
    ↖ mutant

3) nov:

input: 1 (lonelyNumbers(1)) ✓ (7p)

expected: 111

actual: index out of range exception on line 6 -  
This mutation will just process an empty character added in line 2

aov:

input: 2 (lonelyNumbers(2)) ✓ (2p)

expected: 222

actual: 2

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Question 9 (continued)

cvp:

input: 3 (longNumbers(3))

2p

expected: 333

actual: 0 ✓