

## Course PM

### TDA555/DIT440, Introduction to Functional Programming, 7.5hp, HT 2016

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### Course content

- Values, types, and functions
- Compound data structures (lists, tuples, user-defined types)
- Top-down program design
- Recursion and recursive types
- Concept of time complexity, good and bad algorithms
- Input-output
- Modules, abstraction, interfaces, and specifications
- Verification by testing and proof
- Higher-order functions and bulk data operations

### Learning outcomes

After completion of this course, the student should be able to

- Write small functional programs for various applications

- Use a basic repertoire of programming techniques in a typed functional language, such as modelling with datatypes and use of recursion and higher order functions
- Apply software testing techniques using appropriate tools

## Course structure/course implementation

The course is organized as follows:

- 8 weeks in total
- Two lectures per week, on Tuesdays and Fridays, with a couple of reserved slots on Wednesdays for possible guest lectures.
- One exercise session per week, where you can get personal help to understand things; these are done in groups of ~10
- Four lab assignments, spread out over 7 submission deadlines. All lab assignments need to be completed in order to complete the course; these are done in groups of 3, using the groups from the intro course.
- One written exam at the end of the course; this is done individually
- Your final grade will be determined by your grade on the written exam only

## Examination forms

Examination consists of compulsory laboratory exercises and a written exam at the end of the course; see above.

Sample exams are provided at the exams page.

The grades awarded on the exam are 3, 4, 5 for Chalmers students, and G, VG for GU students. (G on the GU side corresponds to 3 or 4 on the Chalmers side; VG corresponds to a 5.)

The exam has a different structure compared to most other exams. Please read this carefully.

The exam is divided into two parts, Part I and Part II.

**Part I:** If you want to get a 3 or a G, you only have to do Part I.

- Part I consists of 5 separate assignments. You have to complete 4 out of 5 assignments in order to pass the exam.
- Typically, each assignment in Part I will have one of the following themes:
  - write a recursive function over a list
  - write a recursive function over a number
  - write a function that needs to use guards

- use a standard higher-order function such as map, filter, or takeWhile to solve a given problem
- write a recursive function over a given recursive datatype
- design your own (recursive) datatype
- write a non-recursive function over a recursive datatype
- simplify the definition of a function that does too much pattern matching, unnecessary case distinctions, has complicated Boolean expressions, etc.
- write a property for a given function
- write a function that does some simple IO (reading/writing files, printing on the screen, user input)

**Part II:** If you want to get a 4, 5, or a VG, you also have to do Part II.

- Part II consists of 2 separate, bigger assignments. If you want to get a 4, you only have to complete one of these (your choice). If you want to get a 5 or a VG, you have to complete both of these.
- Typically, you will encounter the following problems in these assignments:
  - dealing with lists-of-lists, lists-of-tuples
  - advanced uses of list comprehensions
  - doing recursion over a list that does not follow that standard recursion pattern over lists
  - you need to define and use a helper function that was not specified in the assignment
  - writing your own higher-order function
  - dealing with a more complicated recursive datatype
  - dealing with a recursive data structure

“Completing” an assignment means that your answer is judged to be “good enough”. In other words, you are allowed to make some small mistakes in your answer. “Good enough” means that your answer has to show clearly that you would have gotten the answer completely correct if you had had a computer as help, for example.

Points on Part II can be counted towards Part I if needed, but this is very unlikely to happen in practice.

The contents of the exam is: Everything we have talked about in the course, including

- The contents of each lecture
- QuickCheck properties and simple generators
- The contents of the guest lectures

The GUI programming part in lab 4 will not be part of the exam.

The exam will be held on Saturday, Oct 29 (14.00-18.00 in Johanneberg Campus).

## Course literature

The course does not follow a specific book closely, but we will use *Learn You a Haskell for Great Good!* in this course:

<http://learnyouahaskell.com/>

You should also read the slides and code from each lecture, and where available video recordings, since they contain some things that are not in the book, and they are made to give you the necessary background for each lab.

The lectures page gives an overview of the lectures and the recommended reading.

If you are interested, there are a number of Haskell resources available at the links page.

## Changes from Last Year

The main changes from 2015 is that the lectures will be presented in English, and that the students work in lab groups of 3 persons, and the labs are graded orally.

## Schedule

## Week 1

(next week)

**Tuesday, Aug 30**  
(13-15 in HB1)  
Lecture: ["Cases and Recursion"](#)

- Slides: [slides.odp](#), [slides.pdf](#)
- Code: [Code.hs](#), [Work.hs](#)

**Friday, Sep 2** (8-10 in HB1)  
Lecture: ["Data Types"](#)

- Slides: [slides.pdf](#), [slides.pptx](#)
- Code: [Cards.hs](#), [Work.hs](#)

## Week 2

**Monday, Sep 5** (13-16 in Idéläran)  
Exercises: ["Recursion and Datatypes"](#)

**Tuesday, Sep 6** (13-15 in HB1)  
Lecture: ["Recursive Data Types and Lists"](#)

- Slides: [slides.odp](#), [slides.pdf](#)
- Code: [Lists.hs](#), [Work.hs](#)

**Friday, Sep 9** (8-10 in HB1)  
Lecture: ["More Lists"](#)

- Code: [ListComp.hs](#), [Lists.hs](#), [Work1.hs](#), [Work2.hs](#)

## Week 3

**Monday, Sep 12**  
(13-16 in Idéläran)  
Exercises: ["Lists and List Comprehensions"](#)

**Tuesday, Sep 13**  
(13-15 in HB1)  
Lecture: Content adapted to the needs; to be announced

- Code: [QuickCheck.hs](#)

**Friday, Sep 16** (8-10 in HB1)  
Lecture: ["IO Instructions"](#)

- Slides: [slides.odp](#), [slides.pdf](#)
- Code: [ExampleIO.hs](#), [Work.hs](#)

## Week 4

**Monday, Sep 19**  
(13-16 in Idéläran)  
Exercises: ["IO and Testing"](#)

**Tuesday, Sep 20**  
(13-15 in HB1)  
Lecture: ["Test Data Generation"](#)

- Slides: [slides.odp](#), [slides.pdf](#)
- Code: [Insert.hs](#), [Insert work.hs](#), [TestData.hs](#), [Work.hs](#)

**Friday, Sep 23** (8-10 in HB1)  
Lecture: ["Higher-Order Functions"](#)

- Slides: [slides.odp](#), [slides.pdf](#)
- Code: [HigherOrderFunctions.hs](#), [Puzzle.hs](#)

**Monday, Sep 26**  
(13-16 in Idéläran)  
Exercises: "[Higher-Order Functions and Test Data Generation](#)"

**Wednesday, Sep 28**  
(10-12 in HB1)

**Friday, Sep 30** (08-10 in HB1)  
Lecture: "[Recursive Data Types](#)"  
• Slides: [slides.odp](#), [slides.pdf](#)  
• Code: [Expr.hs](#), [ExprVar.hs](#), [Generate.hs](#), [Work.hs](#), [Work ExprVar.hs](#)

## Week 6

**Monday, Oct 3** (13-16 in Idéläran)  
Exercises: "[Recursive Data Types](#)"

**Tuesday, Oct 4** (13-15 in HB1)  
Lecture: "[More Recursive Data Types](#)"  
• Slides: [slides.odp](#), [slides.pdf](#), [zoo.odp](#), [zoo.pdf](#)  
• Code: [ReadExpr.hs](#), [Zoo.hs](#)

**Wednesday, Oct 5**  
(10-12 in HB1)  
Reserved for Guest Lecture (To be decided)

## Week 7

**Monday, Oct 10** (13-16 in Idéläran)  
Exercises: "[Old Exam Questions](#)".

**Tuesday, Oct 11** (13-15 in HB1)  
Lecture: "[Data Structures](#)"  
• Slides: [slides.odp](#), [slides.pdf](#), [typeclasses.odp](#), [typeclasses.pdf](#)  
• Code: [Queue.hs](#), [Queue Work.hs](#), [SlowQueue.hs](#), [SlowQueue Work.hs](#), [Table.hs](#)

**Friday, Oct 14** (8-10 in HB1)  
To be decided

## Week 8

**Tuesday, Oct 18**  
(13-15 in HB1)  
Lecture: "Course Summary"  
We will also go

	Tid	Lokal	Typ	Klass
v 35	Tisdag 30/8			
	13:15 - 15:00	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	Onsdag 31/8			
	10:00 - 11:45	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	13:15 - 15:00	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	15:15 - 17:00	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	Fredag 2/9			
	08:00 - 09:45	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	13:15 - 17:00	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
v 36	Måndag 5/9			
	13:15 - 16:00	2516, 3503-E, 3504-E, 3505-E, 3506-E, 3507-E, 3508-E	Övning	N1COS-1-GU, TKDAT-1
	Tisdag 6/9			
	10:00 - 11:45	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	13:15 - 15:00	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	Fredag 9/9			
	08:00 - 09:45	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	13:15 - 17:00	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
v 37	Måndag 12/9			
	13:15 - 16:00	2516, 3503-E, 3504-E, 3505-E, 3506-E, 3507-E, 3508-E	Övning	N1COS-1-GU, TKDAT-1
	Tisdag 13/9			
	10:00 - 11:45	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	13:15 - 15:00	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	Onsdag 14/9			
	13:15 - 15:00	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	Torsdag 15/9			
	13:15 - 17:00	3354, 3358, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	Fredag 16/9			
	08:00 - 09:45	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	13:15 - 17:00	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
v 38	Måndag 19/9			
	13:15 - 16:00	2516, 3503-E, 3504-E, 3505-E, 3506-E, 3507-E, 3508-E	Övning	N1COS-1-GU, TKDAT-1
	Tisdag 20/9			
	10:00 - 11:45	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	13:15 - 15:00	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	Onsdag 21/9			
	10:00 - 11:45	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	13:15 - 15:00	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	Torsdag 22/9			
	13:15 - 17:00	3354, 3358, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	Fredag 23/9			
	08:00 - 09:45	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	13:15 - 17:00	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
v 39	Måndag 26/9			
	13:15 - 16:00	2516, 3503-E, 3504-E, 3505-E, 3506-E, 3507-E, 3508-E	Övning	N1COS-1-GU, TKDAT-1
	Tisdag 27/9			
	10:00 - 11:45	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	13:15 - 15:00	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	Onsdag 28/9			
	10:00 - 11:45	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	13:15 - 15:00	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	Torsdag 29/9			
	13:15 - 17:00	3354, 3358, ED3582	Laboration	N1COS-1-GU, TKDAT-1

	Tid	Lokal	Typ	Klass
	Fredag 30/9			
v 39	Fredag 30/9			
	08:00 - 09:45	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
v 39	Fredag 30/9			
	13:15 - 17:00	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
v 40	Måndag 3/10			
	13:15 - 16:00	2516, 3503-E, 3504-E, 3505-E, 3506-E, 3507-E, 3508-E	Övning	N1COS-1-GU, TKDAT-1
	Tisdag 4/10			
	13:15 - 15:00	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	Onsdag 5/10			
	10:00 - 11:45	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	13:15 - 15:00	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	Torsdag 6/10			
	13:15 - 17:00	3354, 3358, ED3582	Laboration	N1COS-1-GU, TKDAT-1
v 41	Måndag 10/10			
	13:15 - 16:00	2516, 3503-E, 3504-E, 3505-E, 3506-E, 3507-E, 3508-E	Övning	N1COS-1-GU, TKDAT-1
	Tisdag 11/10			
	10:00 - 11:45	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	13:15 - 15:00	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	Onsdag 12/10			
	10:00 - 11:45	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	13:15 - 15:00	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	Torsdag 13/10			
	13:15 - 17:00	3354, 3358, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	Fredag 14/10			
	08:00 - 09:45	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	13:15 - 17:00	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
v 42	Måndag 17/10			
	13:15 - 16:00	2516, 3503-E, 3504-E, 3505-E, 3506-E, 3507-E, 3508-E	Övning	N1COS-1-GU, TKDAT-1
	Tisdag 18/10			
	10:00 - 11:45	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	13:15 - 15:00	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	Onsdag 19/10			
	10:00 - 11:45	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	13:15 - 15:00	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	Torsdag 20/10			
	13:15 - 17:00	3354, 3358, ED3582	Laboration	N1COS-1-GU, TKDAT-1
	Fredag 21/10			
	08:00 - 09:45	HB1	Föreläsning	N1COS-1-GU, TKDAT-1
	13:15 - 17:00	ED-3507, ED3582	Laboration	N1COS-1-GU, TKDAT-1