Re-Exam (Part 1) in
Program Design and Data Structures (1DL201)

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Instructions

Read and follow these instructions carefully to increase your chance of getting good marks.

- This is a closed book exam. You may use a standard English dictionary. Otherwise, **no notes, calculators, mobile phones, or other electronic devices are allowed.** Cheating will not be tolerated.

- This is a multiple-choice exam. Each question has exactly **one** correct answer.

- You may keep these question sheets. **Only hand in the answer sheet.** Also read the instructions on the answer sheet before you start.

- Raise your hand or approach an exam warden if you have any questions.

Good luck!

Master Theorem

Given a recurrence of the form

$$T(n) = aT(n/b) + f(n)$$

Case 1: If $f(n) = O(n^c)$ where $c < \log_b a$
then $T(n) = \Theta(n^{\log_b a})$.

Case 2: If $f(n) = \Theta(n^c (\log n)^k)$ where $c = \log_b a$ and $k \geq 0$
then $T(n) = \Theta(n^c (\log n)^{k+1})$.

Case 3: If $f(n) = \Omega(n^c)$ where $c > \log_b a$ and the regularity condition holds
then $T(n) = \Theta(f(n))$.
The regularity condition is that for some constant $r < 1$, $a \cdot f(n/b) \leq r \cdot f(n)$ for all sufficiently large n.

Questions

Please choose a single answer for each question. Read the questions carefully, and watch out for negations (*not, except,* etc.).

Question 1: Which of the following is a correct (well-typed) Haskell expression?

A `True || False`   C `0 /= "1"`   E `not [False]`

B `"1" + "2"`   D `1 ++ 2`

Question 2: What is the type of `take 1 [True/=False, 0==1]` ?

A `[Bool]`   C `Bool`   E The expression is not

B `()`   D `[Integer]`   type-correct.

Question 3: What is the value of `take 1 [True/=False, 0==1]` ?

A `()`   C `[True]`   E The expression

B `[0]`   D `True`   throws an exception.

Question 4: Which of the following is a correct Haskell expression that is equivalent to `9 > 5 || 3 < 4 `div` 0` ?

A `if 9 > 5 then 3 < 4 `div` 0`

B `if 9 > 5 then 3 < 4 `div` 0 else False`

C `if 9 > 5 then True else 3 < 4 `div` 0`
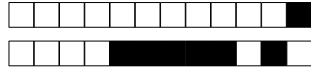
D `if 3 < 4 `div` 0 then True else 9 > 5`

E `if 9 > 5 || 3 < 4 `div` 0 then True`

Question 5: What is the value of `fst ((1,"2"), ("3",4))` ?

A `"3"`   C `(1,"2")`   E The expression is not

B `1`   D `("3",4)`   type-correct.

Question 6: What is the value of the following expression?
```
let
  x = 2
  f y = let x = y-1 in x+y
  y = f x
in
  f y
```

A `1`   B `2`   C `3`   D `4`   E `5`

Question 7: Consider the following function:
```
f 0 y = y
f x y = x
```
What is the value of `f 1 (1 `div` 0)` ?

|A| 0

|B| 1

|C| Infinity

|D| The expression is not type-correct.

|E| The expression throws an exception.

Question 8: Which of the following statements is **false**?

|A| Patterns in Haskell must be linear, i.e., each identifier can occur at most once.

|B| Patterns for tuples and data types can contain other patterns.

|C| The underscore pattern (_) matches any value.

|D| An identifier pattern (e.g., `x`) matches any value.

|E| A constant pattern (e.g., `0`) matches any value.

Question 9: Consider the following function:
```
f x y z = x<y && x<z
```
Which of the following expressions is type-correct?

|A| f 3 2 1

|B| f 'x' 'a' 'y'

|C| f "a" "b" "c"

|D| f 1.0 2.5 1.0

|E| All of them.

Question 10: Which of the following functions is an example of nested recursion?

|A|
```
factorial 0 = 1
factorial n = n * factorial (n-1)
```

|B|
```
gcd a 0 = a
gcd a b = gcd b (a `mod` b)
```

|C|
```
acker 0 n = n+1
acker m 0 = acker (m-1) 1
acker m n = acker (m-1) (acker m (n-1))
```

|D|
```
fib 0 = 0
fib 1 = 1
fib n = fib (n-1) + fib (n-2)
```

|E| All of these.

Question 11: Recall the quicksort algorithm. Suppose the algorithm is applied to the input list `[6,7,3,12,1,7,2,9]` and the value 6 is chosen as the pivot. What are the arguments to the immediate recursive calls of the quicksort algorithm?

A `[7,3,12]` and `[1,7,2,9]`

B 6 and `[7,3,12,1,7,2,9]`

C `[3,1,2]` and `[7,12,7,9]`

D `[6,7]`, `[3,12]`, `[1,7]` and `[2,9]`

E `[1,2,3]` and `[7,7,9,12]`

Question 12: Which of the following is **not** a polymorphic function?

A `&&`   B `map`   C `++`   D `head`   E `length`

Question 13: Let $f(n) = n^2 + 3n + 1000$. Which of the following bounds is **not** correct?

A $f(n) = \Theta(n^2)$ C $f(n) = \Omega(n^2)$ E $f(n) = \Omega(1)$

B $f(n) = O(n^2)$ D $f(n) = O(1)$

Question 14: What is the closed form of the following recurrence?

$$
\begin{aligned}
T(0) &= 0 \\
T(n) &= T(n-1) + 2 \quad \text{if } n > 0
\end{aligned}
$$

A $T(n) = 2n$ C $T(n) = \frac{n^2}{2}$ E The recurrence does not have a closed form.

B $T(n) = n^2$ D $T(n) = (n-2) \cdot 2$

Question 15: Assume $f(n) = O(n^2 + n + 100)$. Which of the following statements is true?

A $f(n)$ is always smaller than 100.

B $f(n)$ is always larger than 100.

C For sufficiently large values of n, $f(n)$ is larger than n.

D For sufficiently large values of n, $f(n)$ is smaller than n^2.

E For sufficiently large values of n, $f(n)$ is larger than n^2.

Question 16: Use the Master Theorem to find a closed form for the following recurrence:

$$T(n) = T(\frac{n}{2}) + 2n$$

The closed form is:

A $T(n) = \Theta(n^2)$ C $T(n) = \Theta(\log n)$ E The Master Theorem does not apply.

B $T(n) = \Theta(n)$ D $T(n) = \Theta(1)$

Question 17: Which of the following functions has a run-time cost that is **not** described by the following recurrence?

$$T(n) = \begin{cases} \Theta(1) & \text{if } n = 0 \\ T(n-1) + \Theta(1) & \text{if } n > 0 \end{cases}$$

Assume n is the length of the argument list.

A
```
a [] = 0
a (x:xs) = a xs + 10
```

B
```
b xs = if length xs == 0 then 0 else b (tail xs) + 1
```

C
```
c xs | xs == [] = 0
     | otherwise = c (tail xs)
```

D
```
d [] = 0
d (x:xs) = x * d xs
```

E
```
e [] = length [1,2,3]
e (x:xs) = e xs + 5
```

Question 18: You have received a new jigsaw puzzle and start assembling the pieces together one by one. This is ...

A a bottom-up approach.

B a top-down approach.

C a dodging technique.

D both a stacking and dodging technique.

E both a top-down and cheating technique.

Question 19: Consider a function `set_hour` that takes an argument `hour` and updates the time. Which of the following is the most appropriate precondition for `set_hour hour`?

A `hour` is a positive integer

B `hour` is an integer

C `hour` is an instance of `Show`

D $0 <$ `hour && hour` ≤ 23

E None of the above

Question 20: Assume a function's precondition is **not** satisfied when the function is called. Which of the following statements is **false**?

| A | The postcondition is not guaranteed. |

| B | Security issues may arise. |

| C | Defensive programming can identify violations of preconditions. |

| D | The compiler will alert the programmer that the precondition is not satisfied. |

| E | The behavior of the code is undefined. |

*Do **not** write above this line!*

Answer Sheet — Exam 1DL201 of 2017-08-22

Instructions: Using a **dark** color, fill in **at most one** answer box (A to E) per question. Fill the answer box **entirely** (■)—we will use an optical character recognition (OCR) system that may not recognize ticks, crosses, circles, etc.

If you think that a question is ambiguous or has no correct answer, mark the question number with a ⋆ and explain **on the backside of this sheet** what the problem is and what assumptions you have made to answer the question.

Transfer your answers from the question sheets to this answer sheet **just before handing in**. If you want to change an answer, then please request a new answer sheet. You may keep the question sheets; at the end of the exam, **only hand in this answer sheet**.

Also fill in your **exam code** in clear handwriting at the bottom of this page.

Grading:

Correct answers	≤ 9	10 − 13	14 − 16	17 − 20
Grade	U	3	4	5

Question 1: ■ B C D E   **Question 11:** A B ■ D E

Question 2: ■ B C D E   **Question 12:** ■ B C D E

Question 3: A B ■ D E   **Question 13:** A B C ■ E

Question 4: A B ■ D E   **Question 14:** ■ B C D E

Question 5: A B ■ D E   **Question 15:** A B C ■ E

Question 6: A B C D ■   **Question 16:** A ■ C D E

Question 7: A ■ C D E   **Question 17:** A ■ C D E

Question 8: A B C D ■   **Question 18:** ■ B C D E

Question 9: A B C D ■   **Question 19:** A B C ■ E

Question 10: A B ■ D E   **Question 20:** A B C ■ E

Again: Please fill your chosen boxes **entirely** and in **dark** color!

Your exam code: