# PG4200 Algorithms and Data Structures

# Re-sit exam

## 6/8/2025

Candidate: 31

### Question 2:

### LO1: Stack(push/pop/getMin operations)

A stack is a linear data structure that follows the Last-in-First-Out (LIFO) principle (Goodrich & Tamassia, 2006). In this task we need a specialized stack that can return the minimun element in constant time.

This can be achieved by maintaining two stacks (Sedgewick & Wayne, 2011):

1. mainStack: Stores all pushed elements
2. minStack: Stores the current minimum after each push.

**Algorithmic explanation:**

We want a stack that supports:

* push(x) – Insert an element into the stack
* pop() – Remove and return the top element
* getMin() – Return minimum element in O(1) time

Algorithm steps (adapted from Gupta, n.d):

Push(x):

1. Push x into mainStack
2. If mainStack is empty or x <= top of mainStack, also push x into minStack

Pop():

1. If mainStack is empty 🡪 return -1
2. Pop the top value from mainStack
3. If this popped value equals the top of minStack, also pop from minStack
4. Return the popped value

getMin():

1. If minStack is empty 🡪 return -1
2. Return top of minStack

Complexity:

* push(x) 🡪 O(1)
* pop() 🡪 O(1)
* getMin 🡪 O(1)
* Space 🡪 O(n) (extra stack for minimum values)

Screenshot from IntelliJ showing the Java implementation of the mainStack and minStack:

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KI-generert innhold kan være feil.

This screenshot shows an example of how the code works:

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This screenshot shows the output:

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Graphical illustration showing both stacks side-by-side at each step:

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KI-generert innhold kan være feil.

## Referances

Goodrich, M. T., & Tamassia, R. (2006). Data Structures and Algorithms in Java (4th ed., Ch.5.1). Wiley.

Sedgewick, R., & Wayne, K. (2011). Algorithms (4th ed., Ch.1.3). Addison‑Wesley.

Gupta, R. (n.d.). LO 1: Understanding Data Structures [Lecture slides]. Kristiania University College.