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# Ghulam Ishaq Khan Institute (GIKI)

## Assignment # 3

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| **Subject:** Data Structures and Algorithms | **Course Code:** CS221 – A - Fall - 25 |
| **Class:** BS (AI) – 3rd Semester – Batch 34 | **Submission Deadline:** 19-Oct-2025 (Saturday) |
| **Course Instructor:** M. Qasim Riaz - Lecturer - FCSE | **Total Marks:** 20 |

**Note (Please Read notes & instructions first)**

- First, read the instructions and statements of Task carefully then write the solution.
- **Just Submit Code file & output file (Viva may be taken later-on)**
- ***For C++ Code File:***
  - For Example, if your roll number is 2022532 and you are doing 3rd assignment then file name of your file should be written as ---> 2022532_3_Code.
  - Now upload file to Microsoft teams.
- ***For Output File:***
  - Take screenshots of your code by showing working / output as mentioned in given task and past it in a word file "**Remember screen shot should contain complete window even the start-menu and date and time shown below at screen don't crop it**"
  - Convert that word file into pdf file and rename your output pdf file as ---> 2022532_3_Output.
- ***Now don't create zip folder just upload directly both files at MS Teams***

## Task: Rearranging Railroad Cars

It's a very nice application of stacks. Consider that a freight train has n railroad cars. Each to be left at different station. They're numbered 1 through n and freight train visits these stations in order n through 1. Obviously, the railroad cars are labeled by their destination. To facilitate removal of the cars from the train, we must rearrange them in ascending order of their number (i.e. 1 through n). When cars are in this order, they can be detached at each station. We rearrange cars at a shunting yard that has input track, output track and k holding tracks between input and output tracks (i.e. holding track).

### Input

When the application is run, it shall ask the user for the following two values: n: Number of railroad cars k: Number of holding tracks

### Output

Your system shall display all the moves from the input track to the holding and the output track. You can create a fancy interface by drawing rectangles on the console. Your output should be legible and show the sequence of moves to rearrange the railroad cars.

## Solution Strategy

To rearrange cars, we examine the cars on the input from front to back. If the car being examined is next one in the output arrangement, we move it directly to output track. If not, we move it to the holding track and leave it there until it's time to place it to the output track. The holding tracks operate in a LIFO manner as the cars enter and leave these tracks from top. When rearranging cars only following moves are permitted:
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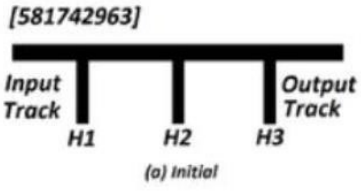
• A car may be moved from front (i.e. right end) of the input track to the top of one of the holding tracks or to the left end of the output track.

• A car may be moved from the top of holding track to left end of the output track. The figure shows a shunting yard with k = 3, holding tracks H1, H2 and H3, also n = 9. The n cars of freight train begin in the input track and are to end up in the output track in order 1 through n from right to left. The cars initially are in the order 5, 8, 1, 7, 4, 2, 9, 6, 3 from back to front. Later cars are rearranged in the desired order.

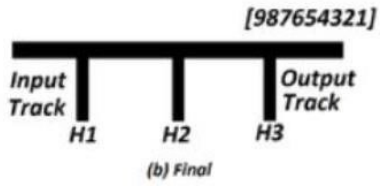
## A Three Track Example

• Consider the input arrangement from figure, here we note that the car 3 is at the front, so it can't be output yet, as it is to be preceded by cars 1 and 2. So car 3 is detached and moved to holding track H1.




• The next car 6 can't be output and it is moved to holding track H2. Because we have to output car 3 before car 6 and this will not be possible if we move car 6 to holding track H1.

• Now it's obvious that we move car 9 to H3. The requirement of rearrangement of cars on any holding track is that the cars should be preferred to arrange in ascending order from top to bottom.

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• So car 2 is now moved to holding track H1 so that it satisfies the previous statement. If we move car 2 to H2 or H3, then we've no place to move cars 4, 5, 7, and 8. The least restrictions on future car placement arise when the new car λ is moved to the holding track that has a car at its top with smallest label Ψ such that λ < Ψ. We may call it an assignment rule to decide whether a particular car belongs to a specific holding track.

• When car 4 is considered, there are three places to move the car H1, H2, and H3.

• The top of these tracks are 2, 6, and 9. So using above mentioned Assignment rule, we move car 4 to H2.

• The car 7 is moved to H3.

• The next car 1 has the least label, so it's moved to output track.

• Now it's time for car 2 and 3 to go to output track from H1 (in short all the cars from H1 are appended to car 1 on output track). The car 4 is moved to output track. No other cars can be moved to output track at this time.

• The next car 8 is moved to holding track H1.

• Car 5 is output from input track. Car 6 is moved to output track from H2, so is the 7 from H3, 8 from H1, and 9 from H3.

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**Best of luck!**
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