# OOP Advanced Exam – CosmosX

You’ve probably heard about Elon Musk and his company Tesla, the idea of which is to find innovative ways of providing energy. Elon got pretty popular around his company, and a certain person heard about it. Meet **Nasko** **Usk and Stoyan Usk** – the guys who got inspired by Elon Musk, and created the company CosmosX.

### Overview

CosmosX is a company, which provides energy through cryogen reactors. The company needs a software to maintain its system and that is why they hired **Nasko and Stoyаn**.They tried to write some software, but they couldn’t manage much, so they will just let you build the rest. You must however use their code, that’s one requirement.

### Tasks

#### Task 1: Business Logic

**Nasko and Stoyan** tried to write some code before you, but they failed… Somehow they have managed to write the ModuleContainer class correctly.

Your first task is to find and fix all of the bugs.

#### Task 2: Input / Output

#### Task 3: Reflection

You must implement а factory using reflection and make it easy to follow the Open/Closed Principle. You are required to implement one factory:

* ReactorFactory

Also, make sure that if you add a new method in the manager class, you won't have to change the Parse method in the CommandParser class.

NOTE: Make sure you reference the Calling Assembly, instead of the Executing Assembly, since the code that’s going to be calling your factories in the tests depends on this!

No static factories are allowed!

#### Task 4: Unit Testing

Like you saw at the beginning, there is а class, which does not need refactoring - ModuleContainer**.** This is the class, against which you need to **write unit tests**. In your skeleton, you are provided with a **perfectly working** ModuleContainer, but it still needs to be **tested**, because in **Judge**, we have prepared some **bugs**, and you need to catch them in your unit tests.

You are provided with a **unit test project** in the **project skeleton**. **DO NOT modify its NuGet packages**.

Note: The ModuleContainer you need to test is in the **global namespace**, as are any entities, which it depends on, so **remove any using statements** pointing towards any entities and controllers before submitting your code.

Do **NOT** use **Mocking** in your unit tests!

### Skeleton

You are allowed to change the **internal** and **private logic** of the **classes** that have been given to you.   
In other words, you can change the **body code** and the **definitions** of the **private members** in whatever   
way you like.

However. . .

You are **NOT ALLOWED** to **CHANGE** the **Interfaces** that have been provided by the **skeleton** in **ANY way**.   
You are **NOT ALLOWED** to **ADD** more **PUBLIC LOGIC**, than the **one**, **provided** by the **Interfaces**, **ASIDE FROM** the ToString() method.

### Structure

The structure of the software circles around Reactors and Modules.

#### Reactors

The Reactors are initialized with id (**int**) and moduleContainer (IContainer).   
There are generally 2 types of Reactors.

##### Cryo Reactor

The CryoReactor is initialized with an additional property:

* CryoProductionIndex – an **integer**.

##### Heat Reactor

The HeatReactor is initialized with an additional property:

* HeatReductionIndex – an **integer**.

#### Modules

The Modules are initialized with an id (**int**).  
There are generally 3 types of Modules.

##### Cryogen Rod

The CryogenRod is initialized with an additional property:

* EnergyOutput – an **integer**.

##### Heat Processor

The HeatProcessor is initialized with an additional property:

* HeatAbsorbing – an **integer**.

##### Cooldown System

The CooldownSystem is initialized with an additional property:

* HeatAbsorbing – an **integer**.

The CryogenRod is an **Energy module**, because they have EnergyOutput.

The CooldownSystem and the HeatProcessor are **Absorber modules**, because they have HeatAbsorbing.

#### ModuleContainer

The ModuleContainer contains 3 collections – 2 for the **Energy** and **Absorbing Modules**, and one to **follow the order of input** of the Modules.

The class exposes **2 methods** for adding Modules – one for the **Energy Modules** and one for the **Absorbing Modules**.

**Before adding** an element, the methods check if there is **capacity** for it. If there is **not enough capacity**, the **first element** entered is **removed**, to make space for the new one.

### Functionality

The functionality of the software involves adding Reactors, adding Modules to the Reactors, and so on. As you see the Reactors and Modules are the main entities of the program. As such, they have an id. That id is universal, for all Reactors and Modules. When you create a Reactor or a Module you **give** it an **id**. When you create another one, you give him the **next id** in order (**previous** + **1**). The ids start from **1**.

In **some** of the **commands**, you’ll receive ids which may refer to a Reactor and a Module. You must check what is the object at that id, and process the command depending on the result.

Each Reactor has a **Module Container**, in which it **stores** its **Modules**.   
The business logic of the program involves: calculating energy output, inspecting reactors and modules, adding more modules and reactors.

Check below, each section, and the functionality it describes.

#### Reactors

The Reactors are actually the ones that provide power. Initially they produce **NO** **power**, because they have no modules. Upon adding a module, it is added to the ModuleContainer of the Reactor.

When the **Module count** of a particular Reactor becomes **equal** to the ModuleContainer’s moduleCapacity, the **first Module entered**, is **removed**, so that there can be place for the new one.

A Reactor has an **energy output** – equal to the **sum** of the energyOutputs of all its **Energy Modules**.  
A Reactor also has **heat absorbing** – equal to the **sum** of the heatAbsorbings of all its **Absorbing Modules**.

If the Reactor is a CryoReactor, you must **multiply** its **energy output** by the cryoProductionIndex.  
If the Reactor is a HeatReactor, you must **add** the heatReduction to the **heat absorbing**.

If the Reactor’s **energy output** is **greater** than the **heat absorbing**, the Reactor **overheats**. If that happens, it’s **energy output** should be **presented** as **0**.

#### Modules

The Modules have no business logic around themselves. They are just **data models**.

#### Commands

There are several commands which are given from the user input, in order to control the program.   
Here you can see how they are formed.

The **parameters** will be given in the **EXACT ORDER**, as the one **specified below**.   
You can see the exact input format in the **Input section**.

**Each** **command** will **generate an output** **result**, which you must **print**.  
You can see the exact output format in the **Output section**.

##### Reactor Command

**Parameters** – **type** (string), **additionalParameter** (int), **moduleCapacity** (int).

Creates a Reactor of the **given type**, with the **next** **id**.   
The type will either be “Cryo” or “Heat”.  
Depending on the **type**, the additionalParameter will be set to either cryoProductionIndex or heatAbsorbing.

The moduleCapacity is set to the ModuleContainer of the Reactor.

##### Module Command

**Parameters** – **reactorId** (int), **type** (string), **additionalParameter** (int).

Creates a Module of the **given type** with the **next id** and **adds** it to the ModuleContainerof the **Reactor** with the **given reactorId**.

The type will either be “CryogenRod”, “HeatProcessor” or “CoolingSystem”.

Depending on the Module type, the additionalParameter will be set to a different property:

* If it’s a CryogenRod the **additionalParameter** will be set ot the energyOutput.
* If it’s a CooldownSystem the **additionalParameter** will be set ot the heatAbsorbing.
* If it’s a HeatProcessor the **additionalParameter** will be set ot the heatAbsorbing.

##### Report Command

**Parameters** – **id** (int)

Brings report of the **Reactor** or the **Module** with the **given id**, providing **detailed** **information** about it.

##### Exit

**Exits** the program. Prints **detailed information** about the **whole** system.

### Input

The input consists of several commands which will be given in the format, specified below: :

* Reactor {reactorType} {additionalParameter} {moduleCapacity}
* Module {reactorId} {type} {additionalParameter}
* Report {id}
* Exit

### Output

Each of the commands generates **output**. Here are the **output formats** of each command:

* Reactor Command – creates a reactor of the given type, with the given id. Prints the following result:

**Created {type} Reactor – {id}**

* Module Command – adds a Module of the given type, with the given id to a specified Reactor.

**Added {moduleType} - {moduleId} to Reactor - {reactorId}**

* Report command – provides **detailed** **information** about a **Reactor** or a **Module**, in one of the following formats:

|  |  |
| --- | --- |
| Reactor | Module |
| {reactorType} – {reactorId}  Energy Output: {energyOutput}  Heat Absorbing: {heatAbsorbing}  Modules: {moduleCount} | {moduleType} Module – {moduleId}  {additionalParam}: {additionalParamValue} |

Because of the fact, that the Module is not particular, the additionalParameter should either be “**Energy Output**” or “**Heat Absorbing**”.

* Exit command – Terminates the program; **prints** detailed statistics about the whole system. The format, in which the statistics should be printed is:

Cryo Reactors: {cryoReactorsCount}  
Heat Reactors: {heatReactorsCount}  
Energy Modules: {energyModulesCount}  
Absorbing Modules: {absorbingModulesCount}  
Total Energy Output: {totalEnergyOutput}  
Total Heat Absorbing: {totalHeatAbsorbing}

* + Energy Modules and Absorbing Modules are all Modules that were registered in the system… Regardless of that whether they were removed in the process, you **print them**.
  + The totalEnergyOutput and totalHeatAbsoring are the **SUMS** of the **corresponding stats** of **all Reactors**.

### Constrains

* All **integers** in the input will be in **range [0, 1.000.000.000]**.
* All **input lines** will be **absolutely valid**.
* There will be **no** non-existent **ids** or **types** in the input.

### Examples

|  |  |
| --- | --- |
| **Input** | **Output** |
| Reactor Cryo 10 10  Reactor Cryo 2 15  Module 1 CryogenRod 100  Module 1 CryogenRod 100  Module 1 CryogenRod 100  Module 1 CryogenRod 100  Module 2 CryogenRod 100  Module 1 HeatProcessor 10000  Report 1  Exit | Created Cryo Reactor - 1  Created Cryo Reactor - 2  Added CryogenRod - 3 to Reactor - 1  Added CryogenRod - 4 to Reactor - 1  Added CryogenRod - 5 to Reactor - 1  Added CryogenRod - 6 to Reactor - 1  Added CryogenRod - 7 to Reactor - 2  Added HeatProcessor - 8 to Reactor - 1  CryoReactor - 1  Energy Output: 4000  Heat Absorbing: 10000  Modules: 5  Cryo Reactors: 2  Heat Reactors: 0  Energy Modules: 5  Absorbing Modules: 1  Total Energy Output: 4000  Total Heat Absorbing: 10000 |
| Reactor Heat 250 10  Module 1 CryogenRod 140  Reactor Cryo 25 5  Module 1 CryogenRod 109  Module 3 CooldownSystem 10000  Module 3 CryogenRod 100  Module 3 CryogenRod 100  Module 3 CryogenRod 100  Module 3 CryogenRod 100  Report 1  Report 3  Module 3 HeatProcessor 20000  Report 3  Exit | Created Heat Reactor - 1  Added CryogenRod - 2 to Reactor - 1  Created Cryo Reactor - 3  Added CryogenRod - 4 to Reactor - 1  Added CooldownSystem - 5 to Reactor - 3  Added CryogenRod - 6 to Reactor - 3  Added CryogenRod - 7 to Reactor - 3  Added CryogenRod - 8 to Reactor - 3  Added CryogenRod - 9 to Reactor - 3  HeatReactor - 1  Energy Output: 249  Heat Absorbing: 250  Modules: 2  CryoReactor - 3  Energy Output: 10000  Heat Absorbing: 10000  Modules: 5  Added HeatProcessor - 10 to Reactor - 3  CryoReactor - 3  Energy Output: 10000  Heat Absorbing: 20000  Modules: 5  Cryo Reactors: 1  Heat Reactors: 1  Energy Modules: 6  Absorbing Modules: 2  Total Energy Output: 10249  Total Heat Absorbing: 20250 |

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