Question 1. The function $T(n) = 2n^2 + \frac{3}{2}n + 1000$ belongs to which of the following complexity cases?

Select one or more:

☒ $O(n^2)$

☒ $O(n^3)$

☒ $O(2^n)$

☒ $\Omega(1)$

☒ $\Omega(n)$

☒ $\Omega(n^2)$

☒ $\Theta(n^2)$

☐ $\Theta(2^n)$

☐ $\Omega(2^n)$

☐ $\Theta(1)$

☐ $\Theta(n)$

☐ $O(1)$

☐ $\Theta(n^3)$

☐ $O(n)$

☐ $\Omega(n^3)$

The leading term is n^2. In order to use the O notation, we need an upper bound (so everything greater than or equal to n^2 is an answer). For the Ω notation we need a lower bound (so everything less than or equal to n^2 is an answer). For the Θ notation we need the exact value (so only n^2 is correct).

The correct answers are:

$O(n^2)$

$O(n^3)$

$O(2^n)$

$\Omega(1)$

$\Omega(n)$

$\Omega(n^2)$

$\Theta(n^2)$

Question 2. Assume that we have an algorithm, which takes three different types of input of size n. These are:

- Type 1: for each input of this type, the algorithm takes time $\Theta(n^4)$. The probability of having this input of this type is $\frac{1}{n^3}$.
- Type 2: for each input of this type, the algorithm takes time $\Theta(n^3)$. The probability of having this input of this type is $\frac{1}{n}$.
- Type 3: for each input of this type, the algorithm takes time $\Theta(n)$. The probability of having this input of this type is 1 - $\frac{1}{n^3}$ - $\frac{1}{n}$.

What is the best case complexity of this algorithm?

Select one or more:

☐ $O(n^4)$

☐ $O(n)$

☒ $\Theta(n)$

☐ $\Theta(n^4)$

☐ It cannot be computed based on the given information.

☐ $\Theta(n^3)$

☐ $O(n^3)$

The best case complexity is the smallest possible complexity that we can have. In our case it is $\Theta(n)$. Remember, for the best case we always use the Θ notation.

The correct answer is:

$\Theta(n)$.

Question 3. Assume that we have an algorithm, which takes three different types of input of size n. These are:

- Type 1: for each input of this type, the algorithm takes time $\Theta(n^4)$. The probability of having this input of this type is $\frac{1}{n^3}$.
- Type 2: for each input of this type, the algorithm takes time $\Theta(n^3)$. The probability of having this input of this type is $\frac{1}{n}$.
- Type 3: for each input of this type, the algorithm takes time $\Theta(n)$. The probability of having this input of this type is 1 - $\frac{1}{n^3}$ - $\frac{1}{n}$.

What is the worst case complexity of this algorithm?

Select one or more:

☐ $O(n^4)$

☐ $O(n)$

☐ $\Theta(n)$

☒ $\Theta(n^4)$

☐ It cannot be computed based on the given information.

☐ $\Theta(n^3)$

☐ $O(n^3)$

The worst case complexity is the greatest possible complexity that we can have. In our case it is $\Theta(n^4)$. Remember, for the worst case we always use the Θ notation.

The correct answer is:

$\Theta(n^4)$.

Question 4. Assume that we have an algorithm, which takes three different types of input of size n. These are:

- Type 1: for each input of this type, the algorithm takes time $\Theta(n^4)$. The probability of having this input of this type is $\frac{1}{n^3}$.
- Type 2: for each input of this type, the algorithm takes time $\Theta(n^3)$. The probability of having this input of this type is $\frac{1}{n}$.
- Type 3: for each input of this type, the algorithm takes time $\Theta(n)$. The probability of having this input of this type is $1 - \frac{1}{n^3} - \frac{1}{n}$.

What is the average case complexity of this algorithm?

Select one or more:

☐ $O(n^4)$

☐ $O(n)$

☐ $O(n^2)$

☐ $\Theta(n)$

☐ $\Theta(n^4)$

☐ It cannot be computed based on the given information.

☐ $\Theta(n^3)$

☒ $\Theta(n^2)$

☐ $O(n^3)$

For the average case complexity we need to use the formula discusses in Lecture 1:

$\sum_{I \in D} P(I) \cdot E(I)$ which gives us $\Theta(n^2)$ Remember, for the average case we always use the Θ notation.

The correct answer is:

$\Theta(n^2)$.

Question 5. Assume that we have an algorithm, which takes three different types of input of size n. These are:

- Type 1: for each input of this type, the algorithm takes time $\Theta(n^4)$. The probability of having this input of this type is $\frac{1}{n^3}$.
- Type 2: for each input of this type, the algorithm takes time $\Theta(n^3)$. The probability of having this input of this type is $\frac{1}{n}$.
- Type 3: for each input of this type, the algorithm takes time $\Theta(n)$. The probability of having this input of this type is $1 - \frac{1}{n^3} - \frac{1}{n}$.

What is the total complexity of this algorithm?

Select one or more:

☒ $O(n^4)$

☐ $O(n)$

☐ $O(n^2)$

☐ $\Theta(n)$

☐ $\Theta(n^4)$

☐ It cannot be computed based on the given information.

☐ $\Theta(n^3)$

☐ $\Theta(n^2)$

☐ $O(n^3)$

For total complexity we take the worst case (n^4), but if the best case has a lower value, we use the O notation. Remember, $O(n^4)$, means that the complexity is at most (n^4),but there is a best case, when it is less (without the best case, we would have $\Theta(n^4)$).

The correct answer is:

$O(n^4)$.

Question 6. What is the correct recurrence relation for computing the complexity of the code below?

```
function recursiveProblem(n) is:
//n is a positive number
    if n ≤ 1 then
        recursiveProblem ← 1
    else
        recursiveProblem ← 1 + recursiveProblem(n - 5)
    end-if
end-function
```

Select one or more:

- [ ] $T(n) = \begin{Bmatrix} 1 \; if \; n \leq 1 \\ T(\frac{n}{5})+n \; otherwise \end{Bmatrix}$
- [ ] $T(n) = \begin{Bmatrix} 1 \; if \; n \leq 1 \\ T(n-5) \; otherwise \end{Bmatrix}$
- [ ] $T(n) = \begin{Bmatrix} 1 \; if \; n \leq 1 \\ T(\frac{n}{5})+1 \; otherwise \end{Bmatrix}$
- [x] $T(n) = \begin{Bmatrix} 1 \; if \; n \leq 1 \\ T(n-5)+1 \; otherwise \end{Bmatrix}$

Question 7. What is the interface of an abstract data type (ADT)?

Select one or more:

☐ The list of all data structures that can be used to implement the ADT.

☒ The list of all possible operations for the ADT.

☐ The set of all possible values that belong to the ADT.

☐ A detailed description of how the ADT is represented in the memory.

The interface of an abstract data type is the set of all operations that exist for that ADT. For every operation the interface contains the header (name + parameters) and the specifications: preconditions, postconditions and eventually the exceptions thrown if the preconditions are violated.

The correct answer is:

The list of all possible operations for the ADT.

Question 8. What should NOT be part of the specifications of an operation in the interface of an abstract data type (ADT)?

Select one or more:

☐ The preconditions

☐ Exceptions thrown by the operation

☐ The list of the parameters

☒ Details about the implementation of the operation

☐ The postcondtions

When we talk about abstract data types, we do not talk about how it is represented and how it is implemented.

The correct answer is:

Details about the implementation of the operation.

Question 9. The *list* and *dict* from Python are data structures.

Select one:

☐ True.

☒ False.

Question 10. A container is a collection of data, in which we can add elements and from which we can remove elements.

Select one:

☒ True.

☐ False.