Formal Languages and Compilers
Prof. Breveglieri, Morzenti, Agosta
Written exam: laboratory question 13/06/2022[1]

Time: 60 minutes. Textbooks and notes can be used. Pencil writing is allowed.
Important: Write your name on any additional sheet.

SURNAME (Cognome): ....

NAME (Nome):..

Matricola:................................or Person Code:..................................

Instructor: ☐ Prof. Breveglieri ☐ Prof. Morzenti ☐ Prof. Agosta

The laboratory question must be answered taking into account the implementation of the `Acse` compiler given with the exam text.

Modify the specification of the lexical analyser (`flex` input) and the syntactic analyser (`bison` input) and any other source file required to extend the `Lance` language with the **`zip`** statement. The `zip` statement takes two source arrays, and copies their elements to a destination array in pairs – that is, by alternating elements from the first array and elements from the second.

The source arrays may be of different lengths, or shorter than required to fill the entire destination array. In these cases, the number of pairs of values copied is determined by the length of the shortest input array. The rest of the destination array is left unchanged. In alternative, the destination array may be shorter than required to contain all the elements from the source arrays. In that case the `zip` statement stops as soon as the last element of the destination array is written. If any of the identifiers does not refer to an array, a syntax error is generated and compilation is stopped.

The syntax and operation of the `zip` statement is shown in the example below. In the first example, the c array is filled with the contents of a and b alternatively, in the order in which they appear in the syntax (first a, then b). The a array is shorter than b, (5 elements vs. 6), so the length of a determines the number of pairs to be copied (5 pairs). The number of elements copied is 10 (5 from a, 5 from b) and the rest of the destination array c is left unchanged. In the second example, a is filled with elements from b and c alternatively. The number of pairs to be copied is determined by the shortest array (b) but the a array is shorter than required. As a result only 2 pairs are copied fully, and the last pair is copied only half-way.

```
int a[5], b[6], c[12];
/* a == [1, 2, 3, 4, 5] */
/* b == [10, 20, 30, 40, 50, 60] */
/* c == [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0] */

c = zip(a, b);
/* c == [1, 10, 2, 20, 3, 30, 4, 40, 5, 50, 0, 0] */

a = zip(b, c);
/* a == [10, 1, 20, 10, 30] */
```

[1]The text and solution to this exam have been adapted to ACSE 2.0 from its initial formulation.

1. Define the tokens (and the related declarations in **scanner.l** and **parser.y**). (1 point)
2. Define the syntactic rules or the modifications required to the existing ones. (2 points)
3. Define the semantic actions needed to implement the required functionality. (22 points)

4. Given the following `Lance` code snippet:

```
-(a * b) / d + 10
```

write down the syntactic tree generated during the parsing with the Bison grammar described in Acse.y *starting from the* `exp` *nonterminal.* (5 points)

5. (**Bonus**) Describe in plain English words how the given implementation of the `zip` statement can be extended such that, when the destination array has not been declared yet, it is instantiated automatically.

   In particular, describe which ACSE utility function needs to be called in order to instantiate the array, and how the size of the array is derived.