1. Which of the two following program fragments will run faster (in an identical HW/SW environment)?

```
int n = 100;
int sum = 0;
for (i = 0; i < n; i++)
   for (j = 0; j < i; j++)
      sum += i+j;
```

```
int n = 75;
int sum = 0;
for (i = 0; i < n; i++)
   for (j = 0; j < n; j++)
      sum += i+j;
```

2. Fill in the missing constant in the given code. The procedure `xyz()` should be called exactly 2100 times.

```
for (i=0; i < 70; i++) {
  j = 0;
  do {
    if (j > ___ ) xyz();
    j++;
  } while (j < 90);
}
```

3. Fill in the missing constant in the given code. The procedure `xyz()` should be called exactly 2000 times.

```
i = 50;
do {
  for (j=0; j < 70; j++)
    if (j > ___ ) xyz();
  i++;
} while (i < 150);
```

4. Fill in the missing constant in the given code. The procedure `uvw()` should be called exactly 49 times.

```
for (i = 0; i < 7; i++) {
  j = i;
  while (j < ___) {
    uvw();
    j++;
  }
}
```

5. Fill in the missing constant in the given code. The procedure `uvw()` should be called exactly 85 times.

```
i = 0;
while (i < 10) {
  for (j = i; j < ___; i++)
    uvw();
  i++;
}
```

6. We need $2k$ operations to process the k-th row of a $n \times n$ Matrix. The total number of operations we need to process the whole matrix is:

a. $2n^2$ b. $(n^2)/2$ *c.* $n(n+1)/2$ *d.* $n(n-1)$ *e.* $n(n+1)$

7. A. The time needed to solve the task T is $C \cdot n^2$, where n is the size of the input data. The task T was solved for a particular input data with $n = 5000$. Then a new computer was bought and its speed is 2.5 times higher than the speed of the the old one. We want to solve the same task in the same time but the data size can be bigger. What is the size of data which can be processed on the new computer in the same time?

7. B. Solve the same problem with different time dependencies:

a. $C \cdot n^3$ b. $C \cdot n^{0.5}$ c. $C \cdot n \cdot \log_2(n)$ ...

8. A machine completes 10^9 operations in one second. The time available for the whole computing task is one hour. Determine the maximum possible size of the input data for the problem to be solved in time. The number of operations needed to process data of size n is $n^{3/2}$.

8. B. Solve the same problem with different operation dependencies:
a. $n^{5/4}$ b. $n \cdot \log_2(n) \cdot \log_2(\log_2(n))$, c. $n^2 \cdot \log_2(n)$

9. The method A requires $n^2 + 17$ operations to compute the result, the method B requires $2n + 80$ operations to compute the same result. The size of input data is n. When is it better to use the method B and when the method A?

10. An array contains some positive and some zero elements. Describe how to organize one single pass through the array which will reorganize the data in such way that all positive elements will occupy the beginning of the array and the zeroes will occupy the rest of the array. The order of positive elements should not change.
Ex: { 3, 0 0, 1, 5 0, 4} $\rightarrow$ {3, 1, 5, 4, 0, 0, 0}

11. Each of the two given lists of integers is sorted in non-decreasing order. Describe a process which will create a third list containing only those values which appear in both given lists. You may scan each of the given lists only once.

12. A sequence S contains positive integers, negative integers and zeroes. Find a contiguous subsequence of S which sum of elements is maximum possible among all contiguous subsequences of S. Is it possible to scan S only once to complete the task? Do not create any additional sequences or big data structures.

13. A list contains N+1 integers, all integers are from interval <1, N>. There is one integer which appears in the list twice, all other integers appear there exactly once. Find the value of the duplicate. You may scan the list only once and utilise only a constant amount of memory.

14. A matrix M of size N×N is given. You have to answer many queries all of which have the same form: "What is the sum of all elements in a submatrix of M which top left corner coordinates are (i1, j1) and bottom right corner coordinates are (i2, j2)?" The values i1, j1, i2, j2 will be different in different queries. You are given an additional memory space equal to the space occupied by M. Decide what kind of preprocessing must be done in order to find an answer to each query in the shortest possible time. The speed of an answer should not depend on particular values of i1, j1, i2, j2.

15. There is a circle C in the x-y plane. The centre of C is the origin point [0, 0] and its radius is R. Describe an algorithm which will find the number of points with integer coordinates which lie inside C. Do not process all integer points inside the circle bounding 2R×2R box, exploit only the points which are close to the boundary of the circle. Write a complete code of your solution.