• Exercises appear at the i1 homepage (http://algo.rwth-aachen.de/en/Lehre/WS1617/TVPS.php) on Monday evening.

• You have eight days to create a solution and it must be done in a group of two or three students.

• Write the name and enrollment number of each group member on every sheet that you hand in.

• To achieve the permission for the exam you must earn 50% of the sum of all points and present one of your solutions at least once.

• You can earn 50% bonus points by presenting your solution. At the beginning of every exercise session, you can mark the exercises that you want to present.

• If a student is not able to present a correct solution although he/she marked the exercise as presentable, he/she will lose all of his/her points on the exercise sheet.

Exercise 1 (4 points)

Let $T(n)$ denote the number of rounds needed to complete a collection of $n$ distinct coupons when drawing one of the $n$ coupons in every round uniformly at random. Then $E[T(n)] = n \cdot H(n)$. Prove the following statement: $E[T(n)] = O(n \cdot \log n)$ with high probability, i.e. for every $c > 0$ there exists an $\alpha_c > 0$ such that $\Pr[X \leq c \cdot (n \log n)] \geq 1 - n^{\alpha_c}$.

Exercise 2 (4 points)

Consider a butterfly network $BF(d)$ as presented in the lecture on slide 5:8, 9/9. Assume that the vertices at the top on this network are sources and the bottom vertices are the sinks. Show that for odd $d$, there exists a permutation $\pi : (0, 1)^d \rightarrow (0, 1)^d$ such that the congestion when using bit-fixing paths in this butterfly-like network is $\Omega(\sqrt{2^d})$.

Exercise 3 (4 points)

Consider a network $M$ with $n$ vertices, degree $\Delta$ and $m \leq n$ fixed source nodes and also $m$ fixed sink nodes. Show that for every oblivious routing protocol at least $\Omega(\frac{m}{\sqrt[4]{\Delta \pi}})$ steps are needed in the worst case.