Instructions

- Remember to justify your answers, and be precise. A good way of replying is to explain your solution as you would to a B.Sc. student studying CS at TKK.
- The problems are to be solved *individually* – *no plagiarism* is tolerated. If you discuss the exercises with other students, please mention their names.

You can hand in your answers by

- handing them to the lecturer at lectures, or
- slipping them into the post box in-between rooms B336 and B337, or
- sending them by e-mail to the assistant (`mjj[AT]tcs.tkk.fi`). In this case the only acceptable file formats are postscript, pdf, and ASCII text. Also, please start the Subject-header with "T-79.5103".

Write all of the following information on the first sheet:

- Course code, name, and year
  "T-79.5103 Computational Complexity Theory 2007"
- Your name and student ID
- Home assignment round (e.g., HA 1)

If you return answers on paper:

- Use paper size A4 only
- If you return multiple sheets, bind them together with e.g. staples
- Please take copies of your sheets in case you want to save them.

If you return answers by email:

- Use the filename lastname-homeassignmentround.fileformat.
  For example: `jarvisalo-1.ps`
- Only file formats ps, pdf, and txt are allowed

Reviewing and Revising Your Answers

You can get feedback on your solution with the assistant on 19.11. right after the tutorial session. If you get less than 1.5 points for some exercise, you then have the possibility to revise your answer. The **deadline for submitting revised answers is 28.11.2007**. Revised answer will be graded using the scale 0 – 1.5.

Deadline for these exercises is 5.11.2007

Exercises (Chapters 9 and 10)

2.1 (0-2 points)

(a) Show that the special case of SAT, in which each clause has either (i) exactly two literals or (ii) at most one negative literal, is **NP**-complete.
(b) In kSAT, there are exactly k literals in each clause. Show by a reduction that 3SAT is at least as hard as the version of 3SAT in which we require exactly one literal in each clause to be true.

2.2 (0-2 points)

IP is the problem of deciding whether a given system of linear inequalities has an integer solution.

(a) Show that any SAT instance can be expressed as an instance of IP.
(b) Argue that IP is **NP**-complete even if the inequalities are known to have a fractional solution. (Start with an instance of SAT with at least two distinct literals per clause.)

2.3 (0-2 points)

Is the following problem **NP**-complete?

INSTANCE: Integer q, finite set X with $|X| = 4q$, and collection C of 4-element subsets of X.
QUESTION: Is there a $C' \subset C$ such that every $x \in X$ occurs in exactly one member of C'?

2.4 (0-2 points)

For an undirected graph $G = (V, E)$, a *core* C is a subset of V such that (i) for any two $u, v \in C$ it holds that $\{u, v\} \notin E$, and (ii) for any $v \in V \setminus C$ there is a $u \in C$ such that $\{u, v\} \in E$. Show that it is **NP**-complete to tell whether an undirected graph has a core of size at most B.

2.5 (0-2 points)

Show that FSAT is **FNP**-complete.