80-311/611, Spring 2004

Computability and Incompleteness

Course Description (Buldt)

- **Lecturer information:**
  - Bernd Buldt (Visiting Prof., U of Konstanz, Germany)
  - Office: BH 155B
  - Mailbox: BH 135 (philosophy dpt.)
  - Email: buldt@cmu.edu
  - Office hours: MWF 11:30–12:30 and by appointment
- **TA information:**
  - Henrik Forsell (Ph.D. student, philosophy)
  - Office: BH A60 B (it's downstairs in the basement)
  - Mailbox: BH 135 (philosophy dpt.)
  - Email: henrik@cmu.edu
  - Office hours: Tuesday 6–8 PM and by appointment
- **Goal.** The goal of this course is to provide you with a concise introduction to Gödel's incompleteness theorems and the basics of recursion theory.
- **Requirements.** You need to have previous knowledge about first-order logic: its language, its interpretation, and doing formalized proofs.
- **Format.** We will have lectures three times a week and a recitation every other Friday. Instead of weekly recitations I offer extended office hours three times a week. Please, do not hesitate to come to my office as soon as you have a question (or two) about what we have done in class. *TAing.* Please, check with the TA if you have a question (or two) concerning homework problems. In addition, Henrik offers weekly meetings during which you can work individually or in groups on homework problems and check with him in case you need some advise or a clue for solving a problem.

- **Literature.** There is no textbook which would cover exactly what we will do in class. Instead of a textbook, I upload lecture notes/slides every Sunday night which cover what we will do during the following week. You might find it helpful to compare my exposition with the treatment in Prof. Avigad's *Lecture Notes*, available at:

  http://www.andrew.cmu.edu/~avigad/teaching.html.

  Although there is no 'official' textbook for this course, I can think of a number of reason why (some of) you might want to buy one nevertheless. The one that comes closest to what we will do in class is,

  > W. Carnielli, R.L. Epstein: *Computability: Computable Functions, Logic, and the Foundations of Mathematics.*, Belmont, CA: Wadsworth/Thomson Learning, 2nd ed. 2000.

  An excellent introductory textbook is:

  > G. Boolos, R.C. Jeffrey (& J.P. Burgess): *Computability and Logic*, Cambridge: Cambridge UP, 4th ed. 2002.

  In addition to these two books I have included some more books to the course reserve; they are:

  - Barwise, J. (ed.): *Handbook fo Mathematical Logic*, Amsterdam 1977; chs C.1 and D.1 offer in a nutshell what we do in the second, first half resp., of class.
  - Barwise, J., Etchemendy, J.: *Turing's World*, Menlo Park/CA ^{3}1993; comes with a program that allows you to build and run Turing machines.
  - Boolos, G.: *The Logic of Provability*, Cambridge 1993; detailed treatment of "provability logic," a bunch of closely related modal logics designed to study Gödelian incompleteness and related phenomena (see also Smoryński below).
  - Odifreddi, P.: *Classical Recusion Theory, vol. 1*, Amsterdam 1989; the most beautiful, rich, and detailed exposition of the recursion theoretic basics this course covers.
  - Shoenfield, J.: *Mathematical Logic*, Reading/MA 1967; an all time classic.
  - Smoryński, C.: *Self-Reference and Modal Logic*, Berlin 1985; same topic as Boolos above, but offers a different treatment and a different selection of modal logics.
  - Soare, R.I.: *Recusively Enumerable Sets and Degrees*, Berlin 1987; the first chapters provide a clear though concise treatment of what we will do in the second half of our course.

- **Assignments.** In order to successfully participate in the course, you have to submit homework assignments and to take two written in-class examinations. Here are the details:

  - Usually, I will give a number of small homework problems at the end of each lecture and summarize them in the weekly homework assignment I upload to the Blackboard System every Friday. Although I encourage you to work on these homework problems as soon as possible (preferably, the night or the day after class), the official deadline is Friday, 5 PM, of the following week.
  - There will be two written in-class examinations; the first one deals with Gödel's incompleteness theorems, the second one with recursion theory.

- **Grades.** Grades will be assigned two times, at the time of the Mid-Semester Break and towards the end of class. Each homework problem comes with a number of points you can earn for successfully solving it (as a rule of thumb: 1P – easy, 2P – moderate, 3P – hard). These points will be added up and converted into grades. Suppose n is the number all of points you can earn. Having earned at least half of them, i. e., $n/2$, means passed (grade D); the number of points between $n/2$ and n will then be divided into equal intervalls corresponding to grade C, B, and A respectively. Those registered with the 611 strand of our class have to solve additional homework problems.

  The final grade (= 100%) will be calculated as follows: The homework assignments contribute 60%, each in-class examination contributes 20% to the final grade.