Intermediate Logic

Class-Times & Location: **T**ues/Th**r**s 4:05-5:25, ENGTR 2100
Instructor: Moritz Bodner (moritz.bodner@mcgill.ca)

Brief Course Description. At the heart of contemporary logic lies a family of questions about the uses and limitations of logic itself. In one way or another, these questions concern the adequacy of various logical techniques. Can they serve the purposes they were designed for? Can a logical proof-system, such as PHIL210's Fitch, be used to construct proofs for every logically true claim? Can a rigorously developed mathematical theory, such as the theory of the real numbers, prove every true claim about the reals (while not proving any untrue claims)? In the engagement with these questions three strands of inquiry are intertwined: (1) developing and refining the logical techniques themselves, (2) formulating precisely the standards they ought to fulfil, and (3) establishing that some of them in particular fulfil – or fail to fulfil – these standards.

This course will focus on some central (and famous) adequacy questions:

- Whether a given logical system is *complete* in the rough sense of «proving everything it ought to prove»? (In particular, whether a system for pure logic proves every logical truth.)

  An especially famous, though negative answer to such a completeness question – which will be discussed at some length – was given by Gödel's 1931 incompleteness results, which established that a certain important mathematical deductive system is, in fact, *not complete*.

  But there are also significant positive completeness results which will be discussed, not least of all the completeness theorem (also due, originally, to Gödel) for pure first-order logic.

- Whether a given logical system is *decidable* in the rough sense of «providing means which will enable its users to find a proof for *any relevant* statement mechanically»?

Posing these questions in a precise, rather than «rough», fashion, and conclusively establishing their answer requires a sophisticated technical framework, which will be developed in three steps:

1. a precise description of «logical systems»,
2. a precise description of certain basic standards to measure such systems against,
3. the introduction of particular «logical systems», accompanied by a rigorous investigation of adequacy questions concerning them, leading to a determinate answer.

   Though this course will focus on the presentation of the these results and the arguments establishing them, there will be some discussion of their philosophical import and historical development.

These three steps will also divide the course itself into three stages: The first two will each take up about a quarter of the term, the third will then occupy the second half of the term.

Course Material. All course material – lectures notes, handouts, (homework) exercises and their solutions – will be provided electronically. No textbook will be required.

That being said, I will mention some recommended textbooks in the first class.

Prerequisites. PHIL210, or a similar introductory course in deductive logic (such as COMP230), will not in practice be presupposed in this course, though any prior familiarity with formal logic will be to your advantage (at least to give you some orientation). In any case, the presentation of the material discussed in this course will be self-contained; that is to say, any relevant material usually covered in an introductory logic course will be presented explicitly in this course.

You should be aware that this is not a typical philosophy course, nor is this course similar in approach or concentration to PHIL210 (or similar introductory deductive logic courses). The standards of argument in logic are more strictly regimented than in (most of) philosophy, and you will be expected (in assignments and exams) to give arguments which live up to these standards.

Evaluation. There will be 10 *homework assignments* to be completed weekly, *worth (in total) 50 %* of the final grade. In addition, there will be a short *in-class mid-term worth 20 %* of the final grade (after the second phase mentioned above); and *a cumulative final exam worth 25 %* of the final grade. 5 % of the final grade will be based on participation/attendance.

Late policy: Assignments handed in late will be penalised at a rate of 5 % of the total marks available on the assignment per week-day, capped at 50 % of the marks achieved. (E.g. an assignment which would receive 8 out of 10 marks if handed in on time, will receive 7.5 if handed in one week-day late, 7 if handed in two week-days late,... but it will receive at least 4 marks (i.e. at least half of the marks achieved).) Homework-assignments submitted after solutions have been made available (usually at most a week after the due-date) will not be accepted.

Tutorial. There will be an informal tutorial to accompany this course (time & location TBD), led sometimes by myself, sometimes by the T.A. It is intended primarily for the discussion of solutions to (past) homework-assignments, as well as difficulties you may have with the current homework-assignments. (I may occasionally also use the tutorial to discuss additional examples, which are not part of any homework, or fill in certain details omitted in the lecture for the sake of time.)

Attendance of this tutorial will not be mandatory, but strongly recommended.

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Language of Submission: "Conformément à la Charte des droits de l'étudiant de l'Université McGill, chaque étudiant a le droit de soumettre en français ou en anglais tout travail écrit devant être noté (sauf dans le cas des cours dont l'un des objets est la maîtrise d'une langue)."

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Inclusivity: "As the instructor of this course I endeavor to provide an inclusive learning environment. However, if you experience barriers to learning in this course, do not hesitate to discuss them with me and the Office for Students with Disabilities, 514-398-6009."

Sustainability: In keeping with McGill's Paper Use Policy (which you can consult on the following site https://mcgill.ca/sustainability/about/policies), I encourage submitting any assignments for this course double-sided – and using re-usable paper-clips or eco-staplers instead of single use staples! – or (except for in-class examinations) digitally.