THE UNIVERSITY OF
MELBOURNE

PHIL30043

The Power and Limits of Logic
(or, *Kurt Gödel's Greatest Hits*)

SUBJECT GUIDE | SEMESTER 1, 2015

Kurt Gödel

SUBJECT OVERVIEW

This subject is all about the *strength* and *limitations* of formal logic. We look at the same sort of logic you might have been taught in an introductory course in formal logic (first order classical predicate logic, to be precise), but we look at it in a new way—we examine it to see what it can *do*, and what it *cannot*. Our aim is to come to grips with the great highlights of logic as it has developed through 20th century—some of the great intellectual advances of the last 100 years as we have came to understand logic better.

We will look at the core notions of *soundness and completeness* (explaining how *proof systems* and *model systems* are two different but complementary ways of representing logical concepts); the notions of being *finite, countably infinite and uncountably infinite,* an their consequences for what can be represented in a language; the boundary between what the *computable* and the *uncomputable,* and the *decidable* and *undecidable* and how we rigorously show that there are *uncomputable functions* and *undecidable problems,* including problems in the foundations of logic itself. The course finishes with Gödel's *incompleteness theorem,* and a discussion of its consequences for the limits of logic.

Concepts and results will be approached by both *practical experience with formal techniques,* and *theoretical reflection on those techniques* enabling students to appreciate the philosophical importance of major logical results, while also equipping them for further study in philosophy or in logic-related areas of other disciplines, like mathematics, linguistics and computer science.

Our aim is to get to grips with the *power* and the *limits* of logical techniques, so we will be both familiarising ourselves with the core intellectual and technical *tools* that are used, and we will critically reflect *on* those tools and what they can do.

TEACHING STAFF

Coordinator:	Prof. Greg Restall
Profile:	Greg is a member of the *Philosophy Department* in the *School of Historical and Philosophical Studies*. He coordinates the weekly *logic research seminar,* and he is Head of the *Philosophy Program*.
Office:	Old Quad 203 (*the North West Corner of the Old Quad, 2 floors up*)
Contact:	8344 0282, restall@unimelb.edu.au
Consultation hours:	Mon. and Wed. 2pm–3pm (Old Quad 203) and by appointment.
Website:	http://consequently.org

LEARNING OBJECTIVES

These are the official "learning objectives" describing what we cover in the subject. Students who successfully complete this subject will

- gain an overview of central areas in 20th Century Formal Logic, and an understanding of their central concepts.

- appreciate the relevance of results and concepts of logic to philosophical issues;

- demonstrate an ability to *prove results* in formal logic, including the soundness and completeness theorems, compactness, the undecidability of the halting problem and logical consequence in first order logic; the undefinability of truth and Gödel's incompleteness theorems.

The website for this subject is available through the Learning Management System (LMS)
at: <http://www.lms.unimelb.edu.au/login/>

The LMS is an important source of information for this subject.
Useful resources such as lecture notes, videos and subject announcements
will be available through the website.

**It is your responsibility to regularly check in with the LMS
for subject announcements and updates.**

You will require a university email account (username and password) to access the Learning Management System. You can activate your university email account at:

<http://www.infodiv.unimelb.edu.au/email/student/activating.html>

HOW THE SUBJECT WILL RUN

There is one single class for the subject. All students are expected to attend a two hour seminar each week.

DAY	TIME	LOCATION
Monday	9am–11am	*757 Swanston St*, Room 715

This class will be run as a seminar, with a great deal of interaction and discussion. *This class is not a traditional lecture.*

The class is complemented by a program of "lecture videos" designed to introduce the core concepts of each section of the course. You will be expected to **watch and study these videos** *before* **each class**. (No week has more than 90 minutes of required material, most often it is 1 hour or less.) The program of lecture videos is found on the "Lectures" section of the LMS.

Each week you are required to **answer a simple quiz** to check your comprehension of the lecture videos *before class* at 9am each Monday. (Except for Week 1, when it is due 9am *Friday.*) The quizzes for each week of lectures are also found on the "Lectures" section of the LMS.

Completion of at least 75% of the quizzes (that's 9 of 12) **by the due date is a hurdle requirement to pass the course**. (The actual *mark* of the quiz does not count for your final grade, but quiz answers will help me focus discussion in the seminars, and will encourage you to watch the videos.)

CLASS PROGRAM & READINGS

Videos from each section of the course are available through the LMS or directly through my website: <http://consequently.org/class/2015/PHIL30043>.

Weeks 1–4: COMPLETENESS

- *Required*: Lecture Slides, Videos and Course Notes—linked on the LMS

- *Recommended*: Chapters 1–6 in Richard Jeffrey *Formal Logic, its Scope and its Limits*, Hackett, 2006.

- *Bonus*:

     Chapter 9, 11 in George Boolos and Richard Jeffrey, *Computability and Logic* (Edition 3), Cambridge University Press, 1989.

     Chapters 9, 10, 19 in George Boolos, John Burgess and Richard Jeffrey, *Computability and Logic* (Edition 4), Cambridge University Press, 2002.

     Chapters 1 to 7 in Raymond Smullyan, *First Order Logic,* Dover, 1993.

- *Background*:

     You need to get up to speed with models and trees propositional and first order predicate logic. The Coursera Videos, linked on the LMS, will be helpful for you.

Weeks 5–6: COMPACTNESS

- *Required*: Lecture Slides and Course Notes

- *Recommended*:

    Stewart Shapiro, "Classical Logic," Stanford Encyclopedia of Philosophy, 2000. <http://plato.stanford.edu/entries/logic-classical/>

    Wilfrid Hodges, "Model Theory," Stanford Encyclopedia of Philosophy, 2005. <http://plato.stanford.edu/entries/model-theory/>

- *Bonus*:

    Chapter 1, 2, 12, 13 in George Boolos and Richard Jeffrey, *Computability and Logic* (Edition 3), Cambridge University Press, 1989.

    Chapters 1, 2, 12–14 in George Boolos, John Burgess and Richard Jeffrey, *Computability and Logic* (Edition 4), Cambridge University Press, 2002.

Weeks 7–9: COMPUTABILITY

- *Required*: Lecture Slides and Course Notes
- *Recommended*: Chapters 7–8 in Richard Jeffrey *Formal Logic, its Scope and its Limits*, Hackett, 2006.

    Neil Immerman, "Computability and Complexity," *Stanford Encyclopedia of Philosophy*, 2008. <http://plato.stanford.edu/entries/computability/>

- *Bonus*:

    Chapters 3–8 in George Boolos and Richard Jeffrey, *Computability and Logic* (Edition 3), Cambridge University Press, 1989.

    Chapters 3–8 in George Boolos, John Burgess and Richard Jeffrey, *Computability and Logic* (Edition 4), Cambridge University Press, 2002.

Weeks 10–12: INCOMPLETENESS

- *Required*: Lecture Slides and Course Notes
- *Recommended*:

    Chapter 9 in Richard Jeffrey Formal Logic, its Scope and its Limits, Hackett, 2006.

    Juliette Kennedy, "Kurt Gödel," Stanford Encyclopedia of Philosophy, 2007. <http://plato.stanford.edu/entries/goedel/>

- *Bonus*:

    Chapters 14–19 in George Boolos and Richard Jeffrey, *Computability and Logic* (Edition 3), Cambridge University Press, 1989.

Chapters 15–18 in George Boolos, John Burgess and Richard Jeffrey, *Computability and Logic* (Edition 4), Cambridge University Press, 2002.

Seminars will involve *peer instruction*, where students are asked multiple choice questions on the topics under discussion, and then discuss their answers together. This means that lecture sessions do not record well, so *seminar sessions will not be recorded and made available online*.

ATTENDANCE & PARTICIPATION REQUIREMENTS

Attendance at seminars is expected. Apologies for absence are also expected.

(The School's policy on *tutorial attendance* is as follows: Students must attend a minimum of 75% of tutorials, unless a higher attendance requirement has been stipulated by the lecturer in charge. *Students who do not fulfill this tutorial attendance hurdle requirement in seminars are in danger of not passing the course*.)

ASSESSMENT

Assessment for this subject consists in:

ASSESSMENT TYPE	PERCENTAGE	DUE DATE
Problem Set	12.5%	4pm Monday March 23 (Week 4)
Problem Set	12.5%	4pm Monday April 20 (Week 7)
Problem Set	12.5%	4pm Monday May 11 (Week 10)
Problem Set	12.5%	4pm Tuesday June 9 (Week 14)
Two-hour exam	50%	Exam period

You must submit all assessment pieces as a *hurdle requirement* for the subject.

Please ensure you are available for the whole exam period. The exam will be centrally timetabled.

Details of the assessment tasks will be made available during the semester on the LMS.

GRADING SYSTEM

A standard grading system applies across all Faculties of the University, as follows:

N 0%–49% **fail** — *not satisfactory*
- Work that fails to meet the basic assessment criteria;

- Work that contravenes the policies and regulations set out for the assessment exercise;
- Where a student fails a subject, all failed components of assessment are double marked.

P 50%–64% ***pass*** — *satisfactory*

- Completion of key tasks at an adequate level of performance in argumentation, documentation and expression;
- Work that meets a limited number of the key assessment criteria;
- Work that shows substantial room for improvement in many areas.

H3 65%–69% **Third-class honours** — *competent*

- Completion of key tasks at a satisfactory level, with demonstrated understanding of key ideas and some analytical skills, and satisfactory presentation, research and documentation;
- Work that meets most of the key assessment criteria;
- Work that shows room for improvement in several areas.

H2B 70%–74% **Second-class honours level B** — *good*

- Good work that is solidly researched, shows a good understanding of key ideas, demonstrates some use of critical analysis along with good presentation and documentation;
- Work that meets most of the key assessment criteria and performs well in some;
- Work that shows some room for improvement.

H2A 75%–79% **Second-class honours level A** — *very good*

- Very good work that is very well researched, shows critical analytical skills, is well argued, with scholarly presentation and documentation;
- Work that meets all the key assessment criteria and exceeds in some;
- Work that shows limited room for improvement.

H1 80%–100% **First-class honours** — *excellent*

- Excellent analysis, comprehensive research, sophisticated theoretical or methodological understanding, impeccable presentation;
- Work that meets all the key assessment criteria and excels in most;
- Work that meets these criteria and is also in some way original, exciting or challenging could be awarded marks in the high 80s or above.
- Marks of 90% and above may be awarded to the best student work in the H1 range.

ASSESSMENT SUBMISSION

You must submit your assessment electronically through the online submission portal on the LMS page. This will act as an electronic receipt of your submission for your records and for the subject coordinator.

As logic assignments contain symbols, which do not translate well when using Microsoft Word formats (.doc or .docx), you should submit your file as a PDF. You can do this either by using an electronic editor (Word, LaTeX, or other typesetting systems) or by handwriting your answers, and scanning to PDF.

Please note that assignments will *not* be accepted via fax or email. You are expected to retain a copy of all work submitted for assessment.

LATE ASSIGNMENTS

Late submission without an approved extension obtained prior to the due date will result in a deduction of 10% per day past the due date, up to a maximum of 5 working days after which the piece of assessment will not be accepted.

If for some reason you think you cannot make a deadline, please see me well before the due date to discuss the possibility of an extension. Extensions will only be granted in special circumstances and will require documentation such as medical certificates for medical conditions.

SPECIAL CONSIDERATION

Special Consideration is available when:

    a.   at any time, your work during the academic year has to a **substantial degree** been hampered by illness or other cause; or

    b.   you have been **prevented** by illness or other cause from preparing for all or part of a component of assessment; or

    c.   you were to a **substantial degree** adversely affected by illness or other cause during the performance of a component of assessment.

Requests for Special Consideration are lodged online at the Student Portal and the requested supporting documentation must be submitted before the application will be considered. Please note the timelines for the lodgement of special consideration. Applications that are lodged outside of these timelines will not be considered.

PLAGIARISM

Plagiarism is the use of another person's work (or a resubmitted version of one's own work) without due acknowledgment. Plagiarism includes:

- direct copying from a book article, web site, or another student's assignment;
- paraphrasing another person's work with minor changes, but keeping the meaning, form and/or progression of ideas of the original;
- piecing together sections of the work of others into a new whole;
- submitting an assignment that has already been submitted for assessment in another subject; and
- presenting an assignment as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor.

Plagiarism is academic misconduct, and is taken very seriously by the University and the Faculty of Arts. Any acts of suspected plagiarism detected by your assessors will be followed up, and any students involved will be required to respond via the Faculty and/or University procedures for handling suspected plagiarism. For more information and advice about how to avoid plagiarism, see the University's Academic Honesty page at <http://academichonesty.unimelb.edu.au/advice.html>.

Ensure that you are aware of how to appropriately acknowledge sources and what referencing style is expected from you in this subject (please ask your tutor or subject coordinator if unsure). The Academic Skills Unit (ASU) has a number of free online resources on referencing at: <http://services.unimelb.edu.au/academicskills/all_resources#research-referencing>