University of Manitoba
Faculty of Science
Department of Mathematics

PRELIMINARY VERSION–STILL SUBJECT TO FURTHER EDITING:

Contents

```
Ancient version.
Update to follow later
```

1   Course Details

Course Title & Number	MATH 3410 A01: Introduction to Mathematical Logic
Number of Credit Hours	3
Class Times & Days of Week MWF	9:30–10:20
Location for classes/labs/tutorials	on-line, via Webex
Prerequisites	MATH 2020 or equivalent, or consent of instructor

2   Instructor Contact Information

Instructor(s) Name	T. G. Kucera
Web Page	https://server.math.umanitoba.ca/~tkucera/
Office Location	430 Machray Hall
Office Hours/Availability	https://server.math.umanitoba.ca/~tkucera/OffHrs.html
Office Phone Number	204-474-6821 (voice mail only checked once or twice a week)
Email	thomas.kucera@umanitoba.ca
	See Section 14 for important information on e-mail regulations.

3   Special Scheduling Announcement

This course is evaluated entirely on assignments, with no final exam. In recent years, students in classes that I have taught in this style have found it convenient to schedule extra classes early in the term so that we can finish lectures about a week before the usual end of classes, and allow extra free time for the completion of the last one or two assignments.

I will attempt to negotiate these extra classes with you; such a scheme can only proceed with unanimous consent.

In the past this additional schedule has usually involved classes of 60-75 minutes starting at 4:30 or 5:30pm, but the discussion will be wide open to all possibilities.

4   General Course Information

Advance information about this course and related courses was provided in the Preliminary Course Announcement at: https://server.math.umanitoba.ca/~tkucera/Logic-20.pdf

5   Course Goals

This course is intended:
(i)   to give students a broad-based appreciation of the different aspects of the Foundations of Mathematics;
(ii)   to give students a sufficient knowledge of the concepts of Mathematical Logic so that they can understand and use these concepts when encountered in other areas of Mathematics;
(iii)   to prepare students for graduate level work in Mathematical Logic.

> Ancient version.
> Update to follow later

6   Textbook, Readings, Materials

There is no set text book for the course. I will follow the presentations in first two of the following books fairly closely. Some supplemental material will be provided as handouts.

A Course in Mathematical Logic, J. Bell and M. Machover, North Holland (1977); available in the bookstore;

Fundamentals of Mathematical Logic, Peter G. Hinman, A K Peters, (2005);

Mathematical Logic, A Course with Exercises, Parts I and II,

René Cori and Daniel Lascar, Oxford University Press, (2000, 2001).

In printed notes, citations to the first two sources will often be made simply by references [BM] or [H].

The Science Library has prepared a Reading List for this course, accessible through the UM-Learn site for this course. The Reading List includes **full access** to Bell and Machover, as well as to many other relevant items.

Not everything that we cover is in these texts; not everything in these texts will be covered; notation (a serious matter in Mathematical Logic) will not correspond exactly to any one of these texts; and topics will be taken in a different order than presented in any one text.

Additional references:

Some other books that you may find particularly useful are those by Enderton, Hamilton, Mendelson, Kleene (**Mathematical Logic**, *not* **Introduction to Metamathematics**) and Shoenfield. Other interesting books are by Barnes and Mack, Benacerraf and Putnam, Delong, Beth, Curry, Goodstein, Hermes, Kneebone, Kreisel and Krivine, Malitz, Manin, Monk, Novikov, Rogers, Smullyan, and Steen. Some of these are philosophical, critical, and/or historical in nature.

7   Using Copyrighted Materials

Please respect copyright. We will use copyrighted content in this course. I have ensured that the content I use is appropriately acknowledged and is copied in accordance with copyright laws and University guidelines. Copyrighted works, including those created by me, are made available for private study and research and must not be distributed in any format without permission. Do not upload copyrighted works to a learning management system (such as UM Learn), or any website, unless an exception to the Copyright Act applies or written permission has been confirmed. For more information, see the University's Copyright Office website at http://umanitoba.ca/copyright/ or contact um_copyright@umanitoba.ca.

Posting/uploading course materials to note-sharing sites is prohibited:

https://umanitoba.ca/admin/vp_admin/ofp/copyright/media/Note_sharing_Web_sites.pdf

PERSONAL COPYRIGHT: I, Dr. Thomas Kucera, assert my copyright over and ownership of the presentations, lectures, and supplementary materials prepared by me which form part of this course. This includes any personalization of content from copyrighted material from our textbooks, all of which will be cited. No audio or video recording of lectures or presentations is allowed in any format, openly or surreptitiously, in whole or in part without my explicit permission. Course materials (both paper and digital) are for the participant's private study and research only. Under no circumstances may course materials be shared with others or posted to the web in any format.

```
Ancient version.
Update to follow later
```

8   Course Evaluation Methods

There will be no formal tests or examinations.

This course is evaluated entirely on the basis of written assignments.

Some of the questions will be quite difficult; there may even be a few to which I do not know the answer. You are not necessarily expected to be able to complete all the problems assigned, but you should do as many as possible and should try to give partial responses to problems that you can't solve. As your final grade is based entirely on the assignments, I expect you to strive not only for correctness, but for a high standard of presentation.

For those that wish to use LaTeX in preparing solutions, I will make my style files and original LaTeX sources for the assignment files available.

Assignments are usually distributed a week and half or so before the due date. You should expect that an assignment will take most of that time to work through; it is generally impossible to do one of these projects the night before it is due. I regard 'perfecting' the assignments as an integral part of the teaching of the course, and you should not hesitate to seek advice from me about your work: whether you need help seeing the way to a solution, or advice on improving your presentation. You cannot lose credit for asking me for advice.

Assigment deadlines have some flexibility built in to them, as long as there is clear evidence (say through time spent consulting with me on your work) that work is being done to improve the assignment. If my announced deadlines conflict with major evaluations in other courses, please let me know and we will make adjustments.

Marking of assignments will be detailed, with critical commentary where warranted, and usually takes 1 to 2 weeks. Full printed solutions to the problem sets will be provided.

9   Grading

There will be seven assignments during the term, worth 30 points each.

A final score is computed by dividing your total marks on the assignments by the maximum score possible, 210. An average of 60% will guarantee a C; an average of 80% will guarantee an A. (Intermediate grades are broken down in equal steps.) An A+ reflects consistent high scores on the assignments (usually an average of 90% or more) and insight into the course material as demonstrated by your solutions. However a single poor assignment will not end your chances of attaining an A+.

```
          Ancient version.
       Update to follow later
```

10   Class Schedule

COURSE OUTLINE:
References are to sections in Bell and Machover (BM) and Hinman (H).
   [L]: "lecture number" (very approximate!)

Chapter 0. Introduction to formal logic

0. Overview (BM Intro, 1.2; H Intro)	[L1]
1. Syntax of propositional and first-order languages (BM 1.2-1.5; H 1.1, 2.1)	[L2–L5]
2. Abstract induction and recursion (H 1.2)	[L5–L7]

Chapter 1. Propositional logic

0. Introduction	[L8]
1. Semantics (BM 1.6; H 1.3, 1.4)	[L8–L9]
2. Disjunctive normal form; adequacy (BM 1.6; H 1.3)	[L10]
3. The Tableau method, weak completeness (BM 1.7–1.9)	[L11–L14]
4. The propositional calculus, the Deduction Theorem (BM 1.10, 1.11; H 1.6)	[L14–L16]
5. Strong completeness, the compactness theorem (BM 1.12, 1.13; H 1.4)	[L17–L18]
6. Other approaches (BM 1.14-1.16; H 1.6)	[L18]

Chapter 2. Introduction to predicate logic

0. Introduction	[L19]
1. Semantics. Structures, isomorphisms and embeddings (BM 2.1, 5.1; H 2.1-2.3)	[L19–L20]
2. Freedom and Bondage (BM 2.2; H 2.2)	[L21–L22]
3. The interaction between syntax and semantics: substitution (BM 2.3; 2.2)	[L23–L24]
4. Connections with Chapter 1	[L24]

Chapter 3. Introduction to recursion theory

0. What is Recursion Theory? Notation and Terminology. Arithmetic functions, Algorithms. (BM 6.1, 6.2; H 1.5, 4.2)	[L25]
1. General recursive functions (BM 6.5; H 4.2)	[L26]
2. A catalogue of recursive functions (BM 6.6)	[L27–L30]
3. Recursively enumerable sets and relations (BM 6.11; H 4.3)	[L31–L37]

ASSIGNMENT SCHEDULE: (Distributed no later than/Due by; Subject to negotiation)

A1. 09-23/10-01	A5. 11-16/11-27
A2. 10-05/10-16	A6. 11-25/12-07
A3. 10-16/10-28	A7. 12-04/12-18
A4. 10-28/11-16	Ancient version. Update to follow later

11   Minimum Technological Requirements

The Faculty of Science has indicated that all students enrolled in this course must ensure they have access to the following:

    i. a computing device where one can create and edit documents;

    ii. an internet connection capable of streaming videos and downloading software; and

    iii. access to a web-cam and microphone.

Classes will consist of live lectures delivered through UMLearn via Webex communications. Contact periods may be held via Zoom or via Webex.

12   Recording Class Lectures

The live Webex lectures and any Webex or Zoom "office hours" may not be recorded by the audience for any reason.

    BE AWARE that the Webex lectures will be recorded by me and posted to the class Webex account; I will make every effort to ensure that no students are identified on those recordings without their permission.

13   Course Technology

It is the University of Manitoba policy that all technology resources are to be used in a responsible, efficient, ethical and legal manner. The student can use all technology in a classroom setting or in a live-streamed lecture setting only for educational purposes approved by instructor and/or the University of Manitoba Student Accessibility Services. UM Learn information:
https://centre.cc.umanitoba.ca/technology/umlearn/.
    Webex information:
https://universityofmanitoba.desire2learn.com/d2l/le/content/6606/viewContent/1423356/View.

14   Class Communications

Note that all communication between you as a student and me as instructor must comply with the Electronic Communication with Students Policy:
    http://umanitoba.ca/admin/governance/media/Electronic_Communication_with_Students_Policy_-_2013_09_01_RF.pdf
    You are required to obtain and use your U of M email account for all communication between yourself and the university.
    Specific advice for communicating with **me** can be found at:
    https://server.math.umanitoba.ca/~tkucera/emailrules.html

```
          Ancient version.
     Update to follow later
```

15   Expectations: I Expect You To

Attend the on-line lectures regularly. The *facts* of the course can be learnd by reading the texts, references and notes; but the *methodsa* are learned by watching me work through matters and by discussing difficulties in class. I will usually try to launch the Webex sessions about 5 minutes before the scheduled class time.

STATEMENT ON ASSIGNMENTS AND ACADEMIC INTEGRITY: Matters of academic integrity as outlined on Schedule 'A' are of special concern in a course where evaluation depends entirely on written work. Submitting another person's work as your own is a serious offense. In particular, this applies to submitting solutions that may be found through on-line resources. If your work is based in part on resources other than the course material, it must be properly documented: full citation in appropriate form of books, papers, or web sites. You are encouraged to discuss your work together and to talk with each other about your assignments: learning can and should be a co-operative effort. This does not mean that copying in any form will be tolerated. Any work submitted for credit must be your own. Please talk to me if you need any clarification of these matters.

Students are NOT permitted to allow anyone other person access to their UM Learn account. Doing so is a breach of the University's Computer Usage Agreements.

Remote Learning Etiquette in the Virtual Classroom:

  (i) Please make sure your microphone is muted when a lecture begins.

 (ii) If you would like to ask a question, please use the chat feature for short questions, or to request an opportunity to ask a live question. Interaction during the lectures is essential to the teaching and learning of the course material.

(iii) Please keep all course communications, including both public and private chats, professional and respectful.

16   Expectations: You Can Expect Me To

I will be lecturing almost exclusively with the aid of a document camera. I will sometimes use previosuly prepared material, but I will often write by hand on paper, exactly as I would in a live lecture.

The lecture sessions will be recorded and available on Webex, usually within 24 hours of the lecture. In the past, video quality has proved to be variable.

I will be available at a wide variety of times for consultation and will keep my Office Hours web site up to date. Assignments will take 1 to 2 weeks to mark.

```
                 Ancient version.
              Update to follow later
```

17   Student Accessibility Services

If you are a student with a disability, please contact SAS for academic accommodation supports and services such as note-taking, interpreting, assistive technology and exam accommodations. Students who have, or think they may have, a disability (e.g. mental illness, learning, medical, hearing, injury-related, visual) are invited to contact SAS to arrange a confidential consultation.

Student Accessibility Services http://umanitoba.ca/student-supports/accessibility
520 University Centre
204 474 7423
student_accessibility@umanitoba.ca

18   Academic Integrity

The Department of Mathematics, the Faculty of Science and the University of Manitoba all regard acts of academic dishonesty in quizzes, tests, examinations or assignments as serious offences and may assess a variety of penalties depending on the nature of the offence.

Acts of academic dishonesty include bringing unauthorized materials into a test or exam, copying from another student, plagiarism and examination personation. Students are advised to read the sections entitled *Academic Integrity* and *Final Examinations: 4. Personations* in the *General Academic Regulations* of the current Undergraduate Calendar. **Note, in particular, that cell phones and pagers are explicitly listed as unauthorized materials, and hence may not be present during tests or examinations.**

Penalties for violation include being assigned a grade of zero on a test or assignment, being assigned a grade of "F" in a course, compulsory withdrawal from a course or program, suspension from a course/program/faculty or even expulsion from the University. For specific details about the nature of penalties that may be assessed upon conviction of an act of academic dishonesty, students are referred to University Policy 1202 (Student Discipline Bylaw) and to the Department of Mathematics policy concerning minimum penalties for acts of academic dishonesty.

All students are advised to familiarize themselves with the **Student Discipline Bylaw**, which is printed in its entirety in the Student Guide; also available on-line or through the Office of the University Secretary. Minimum penalties assessed by the Department of Mathematics for acts of academic dishonesty are available on the Department of Mathematics web-page.

19   Additional Documents

All these are available in the same part of the class UMLearn site as this course outline

i. Mathematics Department Schedule "A"

ii. Faculty of Science general document on the teaching situation this term

iii. Faculty of Science PowerPoint for Students

Last edit: September 2, 2020

Ancient version.
Update to follow later