SYMBOLIC LOGIC: PHIL 220 SYLLABUS

SUMMER TERM 2, 2020
COURSE INSTRUCTOR: MATTHEW SMITHDEAL

GENERAL INFORMATION

DESCRIPTION

Logic, broadly construed, is the study of reasoning. More specifically, it is the study of reasoning. What might we mean when we classify an argument as a "good" one? What makes one argument good and another poor? What do good arguments have in common? Formal logic aims to study these questions from a content-free perspective by abstracting away from the specific meanings of particular sentences and arguments and focusing instead on their underlying structures.

This course will meet in Collaborate Ultra (accessed through Canvas) during the scheduled class times.

COURSE GOALS

By the end of the course, you should be able to:

- Understand the basics of analyzing, evaluating, and symbolizing arguments
- Grasp the basic concepts of first-order logic and truth-functional logic
- Translate sentences and arguments into formal languages
- Understand and utilize the main inference rules of first-order logic and truth-functional logic
- Construct proofs in first-order logic and truth-functional logic
- Identify common, informal fallacies of reasoning

COURSE MATERIALS

REQUIRED TEXT

For All X, Calgary Edition by P. D. Magnus and Tim Button, adapted by Thomas-Bolduc and Richard Zach

This is a ***free, open source*** textbook. There are several different editions of *For All X*. Please ensure you are using the Calgary Edition.

Please use the PDF that is posted in the files section of the canvas site rather than searching for a version on the web. There are frequently slight modifications to the version posted on their website and we want to ensure you have the exact same version. There is also an accessible version of the textbook in the files section.

You may wish to print the textbook. There is a black and white version of the textbook formatted for printing in the canvas files. You can also purchase a printed version of the book on amazon (which may be cheaper than printing it yourself) -- https://www.amazon.ca/dp/1077319851

We will also use carnap.io for homework. More information will be provided the first week of class.

COURSE SCHEDULE

Please note that this schedule may change at the instructor's discretion to suit the pace of the course and the interests of the students. Please also note that all readings are to be read ***before*** the date listed.

Day	Topic and Reading	Work Due
Monday, July 6th	***Introductions and Logic Basics*** Part 1 (Chapters 1-3)	
Wednesday, July 8th	***Formal and Informal Fallacies*** https://www.youtube.com/watch?v=VDGp04CfM4M&list=PLtKNX4SfKpzWShEUtNiV1QhKG2cP9vbXg Watch "Fallacies: Formal and Informal Fallacies" then watch one video from the Fallacies playlist on a fallacy of your choice	Introductory Survey and post due Sunday, July 12th at 11:59 pm PST
Monday, July 13th	***Symbolization Introduction*** Part 2 (Chapters 4-7)	
Wednesday, July 15th	***Truth Tables*** Part 3 (Chapters 8-13)	Homework 1 and Quiz 1 Assigned Due: July 19th 11:59pm PST
Monday, July 20th	***Natural Deduction: Basic Rules*** Part 4 (Chapters 14-16)	
Wednesday, July 22nd	***Natural Deduction: Additional Rules, Soundness, and Completeness*** Part 4 (Chapters 17-20)	Homework 2 and Quiz 2 Assigned Due: July 28th at 11:59 pm PST
Monday, July 27th	***Extra Practice: Deduction in TFL***	
Wednesday, July 29th	***Introduction to First-Order Logic*** Part 5 (Chapters 21-26)	Homework 3 Due: Aug. 2nd at 11:59 pm PST
Wednesday, Aug. 5th	***Natural Deduction for First Order Logic*** Part 7 (Chapters 32-37)	Homework 4 and Quiz 3 Assigned HW Due: Aug. 9th at 11:59 pm PST Quiz Due: Aug. 11th at 11:59pm PST
Monday, Aug. 10th	***FOL Interpretations*** Part 6 (Chapters 26-31)	
Wednesday, Aug. 12th	***Extra Practice with Deduction in FOL***	Homework 5 and Quiz 4 Assigned Due: Aug. 15th at 11:59 pm PST

ASSESSMENT

You have a lot of flexibility in choosing which assignments to complete throughout the course. Students who come to this class with prior exposure to logic or who are particularly self-motivated to complete the course on their own may choose to not complete the homework, extra credit assignments, or attend class – these can all be skipped ***without penalty***. Students that have no background in logic or who would prefer to have more oversight and external motivation to keep up with the course should plan to complete all of the homework, attend classes, and complete the extra credit assignments.

PROFICIENCY BASED ASSESSMENT

This course will use a proficiency-based assessment structure. It is a rather unusual system, so please read the following description carefully and do not hesitate to reach out for clarification at any point.

Short Description:

There are 9 main topics of the course. Your grade will come from demonstrating proficiency in these topics. You only receive credit for completely correct responses, but you will get many chances throughout the semester to display proficiency.

Long Description:

There are 9 main topics for the course (listed below and on Canvas). For each topic, you will find several sub-topics listed in order from foundational to advanced. Your overall course grade will be based on how many of these you have demonstrated proficiency in and how strong your proficiency in each topic is (both during the course and at the completion of the course).

You will have multiple attempts to demonstrate proficiency for a topic during the course. The end goal is that you are proficient in the topics by the end of the course, and you will not be penalized for becoming proficient later in the course rather than earlier.

You will also be granted tokens throughout the course for performing extra tasks. These tokens can be used to alter the course guideline in several ways explained below.

Each assignment will have several questions per topic (at least one covering each of the subtopics for that topic). **The grading of each question on all assignments will be strict. You either get the question correct or incorrect. There is no partial grading of questions.** Rather than a single overall grade on an assignment, you'll receive a ranking of your proficiency on each topic tested on that assignment based on the number of questions you get *entirely* correct, as follows:

- **Perfect:** 100% accuracy on questions for this concept. There are no errors at all. This work could be used as a classroom example. You need not retest on this concept in future quizzes.
    - This correlates to work in the A+ range
- **Excellent**: full proficiency in the concept; >80% accuracy on questions for this concept. There are no non-trivial errors. You need not retest on this concept in future quizzes.
    - This correlates with work in the A range
- **Meets Expectations:** >60% accuracy on questions for this concept. Understanding of the concepts is evidence through correct work. Some revision or expansion is needed, but no significant gaps or errors are present. May retest this concept in future quizzes, but this is not necessary.
    - This correlates with work in the B range

- **Revision Needed:** <60% accuracy on questions for this concept. Partial understanding of the concepts is evident, but there are significant gaps that remain. Needs further work and more review then attempt again on a future quiz.
    - This correlates with work in the C/D range.
- **Not Assessable:** 0% accuracy. Not enough information is present in the work to determine whether there is understanding of the concepts. *Please come discuss this concept with me in office hours so we can strategize how to improve.* Should certainly retest on a future quiz.
    - This correlates with work in the F range.

THE BREAKDOWN

Your overall grade is computed as follows: your score on each primary topic accounts for 10% of your final grade (9 topics x 10% = 90%) and the remaining 10% is awarded based on the completion of an introductory survey and forum post, midterm survey, and final survey (an informal final survey written by me).

Your score for each topic comes from three main sources: 1) quizzes, 2) homework, and 3) the final exam. The homework is optional but will function to decrease the weight of the final exam grade for each topic. These elements are broken down as follows for each topic:

- 40% -- level of proficiency demonstrated on the final exam
- 20% -- level of proficiency demonstrated throughout the course via homework
    - **<u>If you chose not to complete homework on a topic, the entire 60% will come from the proficiency demonstrated on your final exam</u>**
- 40% -- level of proficiency demonstrated throughout the course via quizzes
    - This will come *solely* from the ***highest*** proficiency score on a topic
        - E.g. if you score an R on topic 1 on quiz 1, your score on this topic is R (C/D). If you then score an E on topic 1 on quiz 2, your score on this topic is E (A).
        - In other words, there is no penalty for becoming proficient in a skill later in the course.

HOMEWORK

Again, homework is optional. It functions to reduce the weight of your final exam score on a particular topic. Homework will be assigned every Wednesday starting in week 2 and will always be due the following Sunday at 11:59pm (Vancouver time). You may redo the homework assignment as many times as you'd like within this period. Only the highest score will count. Note that subsequent iterations of the homework assignments may not have exactly the same questions as the first iteration. You are welcome and encouraged to collaborate with other students on the homework via the Canvas forums. You should complete the homework before attempting the quizzes.

The deadline for a homework assignment can be extended by 48 hours by redeeming 1 token. No questions asked or reasons needed. (The only exception to this may be the final homework assignment, depending on when the final exam is scheduled. I won't allow homework to be extended beyond the final exam.)

QUIZZES

You will be assigned 4 quizzes throughout the course. Quizzes will be assigned on a Wednesday and must be completed by the following Sunday at 11:59pm (Vancouver time). The quizzes can be taken at any point in this period. (There are exceptions to this pattern with quiz 2 and 3 – please see the schedule above.)

The first 3 quizzes will each cover 3 new topics plus all previous topics. The 4th quiz will cover all 9 topics. ***You only need to complete the questions on topics for which you have not previously demonstrated adequate proficiency***. The quizzes will be structured as follows:

- Quiz 1: Topics 1-3 (Logic and Symbolization Fundamentals)
- Quiz 2: Topics 1-6 (Truth-functional Logic)
- Quiz 3: Topics 1-9 (First-order Logic)
- Quiz 4: Topics 1-9
- For each quiz, you only need to complete the questions designated for topics that you have not previously completely mastered. ***You choose which topics you want to attempt on each quiz***.
- If you fully master all 9 topics on the first 3 quizzes, you need not attempt quiz 4 at all.

They will be timed and must be completed in a single sitting (if you frequently have internet connectivity issues, please reach out beforehand and we can make arrangements). **Note:** while each quiz covers 3 more topics than the previous quiz, the time allocated to each quiz will ***not*** increase proportionally (e.g. quiz 2 won't have double the amount of time as quiz 1). The reason for this is primarily that you should be focusing your practice on several skills that you wish to better understand and attempting to hone a deeper proficiency of those skills, rather than trying to attain more superficial mastery of many skills.

- For example, say you demonstrate full, E-level proficiency on topics 1 and 2 and M-level proficiency on topic 3 on the first quiz. You don't need to complete questions on topics 1 and 2 on quiz 2 since you've already demonstrated fully proficiency.
- You now need to choose which topics to attempt on quiz 2:
    - You may be happy with an E on topic 3, so decide to only attempt questions on topics 4-6 during quiz 2.
    - You may attempt all 4 that you haven't demonstrated full proficiency in (topics 3-6).
    - Given the time limit for quiz 2, you may decide that you want to focus on demonstrating full proficiency in topics 3-5 or just 3 and 4.
    - Ultimately, it depends on how much time you think you need to demonstrate proficiency in a topic by answering each question on that topic accurately.

FINAL EXAM

The final exam will take place during the officially designated final exam period (TBD). The format will mimic quiz 4 and it will cover all 9 units. Your proficiency of each topic will be ranked on the PEMRN scale just like the quizzes. The depth of proficiency you demonstrate for each topic on the final exam will constitute 60% of your grade for that topic (or 40% if you completed the relevant homework). You should attempt each topic, regardless of whether you demonstrated proficiency on the quizzes.

ATTENDANCE

Attendance is heavily encouraged, but not required. You will be granted a token for each full week of class you attend the full duration of the class and participate (5 possible full weeks). All lectures will be recorded and made available to watch on Canvas (through Collaborate Ultra).

FORUM POSTS

One objective of this course is the development of collaborative study habits. You are expected to ask clear questions about the course material and homework in class and on the discussion board, as well as to explain topics to and answer questions from your peers. For each response to a question you post on the forums that receives 3+ upvotes/likes, you will receive one token.

COURSE PROFICIENCIES

The 9 core topics that you're expected to demonstrate proficiency in by the end of the course as listed below. The subtopics for each main topic are listed from foundational to advanced. Next to each main topic are the primary chapters that focus on that topic.

1. ***Arguments and Validity in English (1-3)***
    a. Correctly state the definitions of sentences (and distinguish examples of sentences that are or are not examples in logic), logical consequence, validity, soundness, equivalence, and joint possibility of English sentences and arguments.
    b. Identify premises and conclusions
    c. Define necessary truth, falsehood, contingency, and necessarily equivalence
    d. Correctly assess an English argument for validity and English statements for necessary truth, falsehood, equivalence, and contingency
    e. Clearly and cogently explain why an argument is or is not valid.
2. ***Informal Fallacies***
    a. Identify examples of each formal and informal fallacy and distinguish between formal and informal fallacies
    b. Correctly define any of the formal and informal fallacies discussed
    c. Construct novel examples of any of the formal and informal fallacies discussed
3. ***Symbolization in Truth-functional Logic (4-7)***
    a. Correctly symbolize English sentences involving basic connectives (negation, conjunction, disjunction, conditional, biconditional) given a symbolization key
    b. Correctly symbolize English sentences involving more complex connectives (e.g. "unless", "neither…nor…", exclusive "or") given a symbolization key
    c. Correctly symbolize all of the English sentences in an argument and construct your own symbolization key
    d. Identify the main connective of a sentence and the scope of each connective in a sentence
    e. Recognize English sentences that are ambiguous and symbolize different readings in TFL
4. ***Core Logic Concepts in TFL (8-13)***
    a. Correctly state the definitions of truth functional, contradiction, entailment, equivalence, joint satisfiability, and tautology in TFL
    b. Correctly and cogently explain relationships between entailment, satisfiability, equivalence, and tautologies.

c. Correctly and cogently explain and give examples of indicative conditionals vs subjunctive conditionals

5. Truth Tables (8-13)

a. Construct the complete truth table for a sentence or sentences in TFL
b. Use a truth table to determine entailment, satisfiability, equivalence, and tautologies, and to find satisfying valuations
c. Determine whether a complete or a partial truth table is needed to demonstrate the concepts in (b) and construct a partial truth table when appropriate

6. Proofs in TFL (14-20)

a. Correctly state the definition of formal proof, sub-proof, theorem, provably equivalent/inconsistent/consistent/valid, syntactic contradiction, and syntactically contingent
b. Give correct formal proofs of arguments involving and, or, if without nested sub-proofs
c. Give correct formal proofs of arguments and theorems involving and, or, if, not and nested sub-proofs, using proof construction strategies
d. Demonstrate whether a sentence or sentences is a theorem, contradiction, jointly consistent, valid using a derivation or a truth table.
e. Give correct formal proofs of theorems requiring the IP rule

7. Symbolization in FOL (21-26)

a. Correctly symbolize sentences and arguments without nested quantifiers and with many-placed predicates
b. Correctly symbolize sentences and arguments involving identity, at least, at most, exactly
c. Identify free and bound variables; explain scope in FOL
d. Correctly and cogently explain why a symbolization of a sentence or argument is a good symbolization or a bad symbolization

8. Interpretation in FOL (27-31)

a. Determine whether sentences are true or false given an interpretation (including a diagrammatic interpretation)
b. Provide interpretations of a sentence to demonstrate that the sentence is not a validity or a contradiction, that a pair of sentences are not logically equivalent or are jointly satisfiable, that an argument is invalid
c. Clearly and cogently explain why a single interpretation or counter-interpretation suffices or if we must reason about all interpretations to demonstrate validity, a contradiction, equivalence, satisfiability, validity, and entailment

9. Proofs in First-order Logic (31-37)

a. Correctly complete formal proofs with quantifiers given justifications or sentences.
b. Prove whether a pair of sentences is provably equivalent or give an interpretation to show that they are not. Prove whether an argument is valid or give an interpretation to show that it is invalid.
c. Correctly construct formal proofs of arguments not requiring IP.
d. Correctly construct formal proofs of arguments requiring IP.