Mathematical Logic (REAS)
CTY Course Syllabus

Day	Time	Topics/Activities	Additional Notes/Materials Needed
Day 0 (Sunday)	Evening	1. Introductions/Icebreakers; Honor Code; Survey 2. Class Expectations and Rules of Conduct	• CTY Bingo • CTY Honor Code • Course Survey
Day 1 (Monday)	Morning	1. Discussion: What is Mathematical Logic? 2. Pre-Assessment 3. Intro to Propositional/Sentential Logic; Syntax vs. Semantics; Logical Connectives; Well-formed formulas	• Pre-Test • Worksheets
	Afternoon	1. Translations between informal and formal language 2. Tarski's definition of truth 3. Analyzing truth assignments 4. Intro to Smullyan Knight/Knave logic puzzles	• Worksheets • Smullyan Puzzles
	Evening	1. More exercises 2. Smullyan Logic Puzzles	Worksheets/Puzzles
Day 2 (Tuesday)	Morning	1. Tautologies, Contradictions, Contingencies 2. Determining tautologies via intuition/guess-and-test 3. Intro to Truth Tables; Logical Equivalence; Inverse/Converse/Contrapositive 4. Making and using truth tables	Worksheets

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	Afternoon	1. Logical Replacement Laws (Double Negation, De Morgan's Laws, Distribution, Conditional Exchange, Biconditional Exchange, Exportation, Commutation, Association, Contraposition, Dup.) 2. Using the logical replacement laws	Worksheets
	Evening	1. Challenge: Finding formulas to match truth table columns 2. Conjunctive/Disjunctive Normal Form	
Day 3 (Wednesday)	Morning	1. Truth-functional completeness; necessity of negation/redundancy of other connectives 2. Intro to Formal Propositional Arguments 3. Video: Argument Clinic (What is/isn't an argument?) 4. Validity/Soundness 5. Using truth tables to determine validity	Worksheets
	Afternoon	Short Truth Table Method; advantages and disadvantages	Worksheets
	Evening	1. More practice with validity of arguments 2. More Smullyan Puzzles (Gold or Tiger?)	Smullyan Puzzles

Day	Time	Topics/Activities	Additional Notes/Materials Needed
Day 4 (Thursday)	Morning	1. Intro to Natural Deductions; Logical Rules of Inference (Simp., Modus Ponens, Hypothetical Syllogism, etc.) 2. Writing basic proofs using inference rules	Worksheets
	Afternoon	1. Incorporating the replacement laws in proofs 2. More practice with formal proofs	Worksheets
	Evening	1. Reading: "What the Tortoise Said to Achilles" 2. Activity: Logic Quest #1	
Day 5 (Friday)	Morning	1. Intro to Proof Structures/Techniques 2. Direct Proofs w/Assumptions (C.P.) a) "If/Then" proofs b) "Or" proofs c) "Iff" proofs 3. Writing conditional proofs	Worksheets
	Afternoon	1. Indirect Proof/Proof by Contradiction (I.P.) 2. Writing indirect proofs 3. More practice with direct/indirect proofs	Worksheets
(Sunday)	Evening	Refresher: continue working on validity and proofs in propositional logic	

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Day 6 (Monday)	Morning	1. Intro to the Tree Method 2. Using the tree method to identify tautologies and validity 3. Satisfiability 4. Using truth tables and tree method to determine satisfiability	Worksheets
	Afternoon	1. Provability and consistency; connection to satisfiability 2. Soundness and Completeness of Propositional Logic 3. Determining if sets of sentences are consistent	Worksheets
	Evening	1. Continue practicing the Tree Method 2. Activity: “Einstein’s Logic Puzzle”	
Day 7 (Tuesday)	Morning	1. Intro to (Naïve) Set Theory; Set operations; relationship to logical connectives; Venn diagrams 2. Basic set theory 3. Categorical Logic 4. Venn diagrams in Categorical Logic	Worksheets
	Afternoon	1. Intro to Predicate/First-Order Logic 2. Monadic/Unary Predicates; Singular sentences 3. Translating between informal and formal language	Worksheets
	Evening	1. More practice with predicates 2. Challenge: Find the spies 3. Challenge: Finding a set-theoretic expression to match a Venn Diagram	

Day	Time	Topics/Activities	Additional Notes/Materials Needed
Day 8 (Wednesday)	Morning	1. Intro to universal and existential quantifiers; well-formed formulas; quantifier scope; sentences (free and bound variables) 2. Translating between formal and informal language	Worksheets
	Afternoon	1. Validity of monadic first-order arguments 2. Using the tree method to determine validity of monadic first-order logic arguments	Worksheets
	Evening	1. More practice with validity of monadic first-order logic arguments (with quantifiers) 2. Birthday Candle Logic Puzzle	
Day 9 (Thursday)	Morning	1. Natural Deductions in First-Order Logic; new inference rules (E.I., U.I., E.G., U.G.) 2. Writing formal proofs in monadic first-order logic	Worksheets
	Afternoon	1. First-Order logic with binary and higher predicates; wffs; sentences 2. Translations between formal and informal language 3. Research Project Discussion and Lottery	• Worksheets • Research Project Packet
	Evening	1. More practice with proofs and translations in F.O.L. 2. Activity: Logic Quest #2	

Day	Time	Topics/Activities	Additional Notes/Materials Needed
Day 10 (Friday)	Morning	1. Translations in First-Order Logic (Cont'd) 2. Proofs in First-Order Logic (Cont'd) 3. Begin work on research project	• Worksheets • Computer Lab
	Afternoon	Continue work on research project	Computer Lab
(Sunday)	Evening	1. Finish work on research presentations 2. More practice with deductions/validity	Computer Lab
Day 11 (Monday)	Morning	Student presentations	
	Afternoon	Student presentations	
	Evening	1. More practice with proofs in First-Order Logic 2. Self-Referential Logic Puzzles	
Day 12 (Tuesday)	Morning	1. Invalidity of Relational First-Order Arguments; Model-Theoretic Method; Natural Interpretation Method 2. Finding counterexamples to invalid arguments	Worksheets
	Afternoon	1. Using the tree method on invalid relational first-order logic arguments 2. Decidability 3. Soundness and Completeness of First-Order Logic 4. Gödel's Incompleteness Theorems (Def. of a Theory, Peano Axioms)	
	Evening	Challenge: Black or White Logic Puzzle	

Day	Time	Topics/Activities	Additional Notes/Materials Needed
Day 13 (Wednesday)	Morning	1. Gödel's Incompleteness Theorems (Continued) 2. Tarski's Undefinability Theorem 3. Paradoxes in Set Theory; Russell's Paradox; ZF Axioms 4. Informal Proofs (Direct, Contradiction, Contrapositive)	Worksheets
	Afternoon	1. Informal Proofs, Continued (Cases) 2. Mathematical Induction	Worksheets
	Evening	1. More practice with informal proofs 2. Begin reviewing for Post-Assessment	
Day 14 (Thursday)	Morning	Activity: Jeopardy! (Mathematical Logic Edition)	
	Afternoon	1. Post-Assessment 2. Student Program Evaluations	• Post-Test • SPE's
Day 15 (Friday)	Morning	Final Activities/Goodbyes	