Colonnade FOUNDATIONS Assessment
2021-2022

Potter College of Arts and Letters	*Department of Philosophy*
Philosophy Major (745) and Philosophy Minor (429)	
Michael Seidler (Program Director) and Landon Elkind (Assessment Coordinator for Philosophy Courses in the Quantitative Reasoning Colonnade Category)	

Please select the option(s) that best describe all sections of this course (you may select more than one):

☒ Taught 100% face to face

☐ Taught 100% online

☐ Mix of online and face to face

☐ Includes dual credit

Student Learning Outcome 1

Student Learning Outcome	Students will demonstrate the ability to interpret information in mathematical and/or statistical forms		
Measurement Instrument 1	Directly measures student learning with assignments that involve truth trees and/or truth tables, which involve a (usually student-generated) diagram on the page that must be interpreted for what it tells a reader about the argument. Rubric for this measure is enclosed as are sample assessments (Assignment 3).		
Criteria for Student Success	Students will have demonstrated their achievement of SLO1 when they can correctly complete the truth tree and/or truth table and interpret what it says about validity such that their written work shows either no mistakes or mistakes that are only of a typographical nature (e.g. a variable “M” is accidentally written and/or typed as “N” and it is clear from the students work as a whole that “M” was intended.		
Program Success Target for this Measurement	80% of students will have reached Milestone 3 in the course (earning 3-out-of-4 on the rubric), represented by 75% or higher in their grade.	**Percent of Program Achieving Target**	80% (one sampled student received a 60%, another did not submit this assignment)
Methods	We sampled assignments from 10 students ($N = 33$), or 33% of the students enrolled. These students were a mixture of honors and non-honors students proportional to actual honors and non-honors enrollments in the course: we had 9 honors and 24 non-honors in the course; so we sampled 3 honors students and 7 non-honors students. Students were each given a number, then a random-number generator was used to determine which students would have their assessments sampled. Grades for these students’ assignments were then conferred.		
Based on your results, highlight whether the program met the goal Student Learning Outcome 1.	☒ **Met**	☐ **Not Met**	

Follow-Up (Provide your timeline for follow-up. If follow-up has occurred, describe how the actions above have resulted in program improvement.)
As we to improve our assessment practices and make them more meaningful and effective, it's important to craft a plan for the following year's assessment – this process assists in "closing the loop" and explains, based on the current data, how you might shift your assessment practice the following year. Whatever your plan is, provide a narrative, in future tense, that indicates how you will approach future assessments. **All changes need not lead to quantitative results – the target scores are just indicators**. Feel free to use more qualitative indicators or observations as appropriate. Please include any discussion about differences in mode of delivery and/or delineation regarding changes to the assessment process that might need to occur based on that modality (e.g. online versus face to face)

Student Learning Outcome 2

Student Learning Outcome	Students will demonstrate the ability to illustrate and communicate mathematical and/or statistical information symbolically, visually, and/or numerically.		
Measurement Instrument 1	Directly measures student learning with assignments that involve translation exercises, which involve a (usually instructor-generated) argument in English that must be represented in symbolic formulas so as to communicate their mathematical content. Rubric for this measure is enclosed as are sample assessments (Assignment 1).		
Criteria for Student Success	Students will correctly translate English arguments into propositional logic, showing awareness of scope and ambiguity issues in English sentences by correctly placing parentheses and similar scope markers in the symbolic formulas that translate the English sentences.		
Program Success Target for this Measurement	80% of students will have reached Milestone 3 in the course (earning 3-out-of-4 on the rubric), represented by 75% or higher in their grade.	**Percent of Program Achieving Target**	90% (one student earned 70%)
Methods	We sampled assignments from 10 students (*N* = 33), or 33% of the students enrolled. These students were a mixture of honors and non-honors students proportional to actual honors and non-honors enrollments in the course: we had 9 honors and 24 non-honors in the course; so we sampled 3 honors students and 7 non-honors students. Students were each given a number, then a random-number generator was used to determine which students would have their assessments sampled. Grades for these students' assignments were then conferred.		
Based on your results, circle or highlight whether the program met the goal Student Learning Outcome 2.	☒ **Met**	☐ **Not Met**	
Follow-Up (Provide your timeline for follow-up. If follow-up has occurred, describe how the actions above have resulted in program improvement.)			

Student Learning Outcome 3

Student Learning Outcome	Students will demonstrate the ability to determine when computations are needed and to execute the appropriate computations.
Measurement Instrument 1	Directly measures student learning with assignments that involve proofs, meaning students must look at the formulas and identify which ones are needed to solve a logical problem (that is, to transform and combine the premises so as to demonstrate the conclusion). Rubric for this measure is enclosed as are sample assessments (Assignment 6).

Criteria for Student Success	Students will correctly solve the proof exercises, so that they will get to the conclusion from the given premises and not make any mistakes in reasoning and very few (if any) unnecessary steps (which are steps that are logically correct but do not approach the conclusion).		
Program Success Target for this Measurement	80% of students will have reached Milestone 3 in the course (earning 3-out-of-4 on the rubric), represented by 75% or higher in their grade.	**Percent of Program Achieving Target**	80% (two students earned 70%)
Methods	We sampled assignments from 10 students (*N* = 33), or 33% of the students enrolled. These students were a mixture of honors and non-honors students proportional to actual honors and non-honors enrollments in the course: we had 9 honors and 24 non-honors in the course; so we sampled 3 honors students and 7 non-honors students. Students were each given a number, then a random-number generator was used to determine which students would have their assessments sampled. Grades for these students' assignments were then conferred.		
Based on your results, circle or highlight whether the program met the goal Student Learning Outcome 3.		☒ **Met**	☐ **Not Met**
Follow-Up (Provide your timeline for follow-up. If follow-up has occurred, describe how the actions above have resulted in program improvement.)			

Student Learning Outcome 4

Student Learning Outcome	Students will demonstrate the ability to apply an appropriate model to the problem to be solved.		
Measurement Instrument 1	Directly measures student learning with assignments that involve providing counterexamples to the validity of an argument (that is, a model of the invalidity of an argument), meaning students must look at the formulas and identify which substitutions of sentences make the premises all true and the conclusions all false. Rubric for this measure is enclosed as are sample assessments (Assignment 1).		
Criteria for Student Success	Students will be able to construct a counterexample to the validity of an argument (that is, a model of the invalidity of an argument) by reading the symbolic formulas and then choosing appropriate English sentences for the variables contained in those formulas.		
Program Success Target for this Measurement	80% of students will have reached Milestone 3 in the course (earning 3-out-of-4 on the rubric), represented by 75% or higher in their grade.	**Percent of Program Achieving Target**	90% (one student earned 70%)
Methods	We sampled assignments from 10 students (*N* = 33), or 33% of the students enrolled. These students were a mixture of honors and non-honors students proportional to actual honors and non-honors enrollments in the course: we had 9 honors and 24 non-honors in the course; so we sampled 3 honors students and 7 non-honors students. Students were each given a number, then a random-number generator was used to determine which students would have their assessments sampled. Grades for these students' assignments were then conferred.		
Based on your results, circle or highlight whether the program met the goal Student Learning Outcome 4.		☒ **Met**	☐ **Not Met**
Follow-Up (Provide your timeline for follow-up. If follow-up has occurred, describe how the actions above have resulted in program improvement.)			

<table>
<tr><th colspan="4">Student Learning Outcome 5</th></tr>
<tr><td>Student Learning Outcome</td><td colspan="3">Students will demonstrate the ability to make inferences, evaluate assumptions, and address limitations in estimation modeling and/or statistical analysis.</td></tr>
<tr><td>Measurement Instrument 1</td><td colspan="3">Directly measures student learning with assignments that involve proofs, meaning students must look at the formulas and identify which rules of inference are applicable, which assumptions can and should be made, and correctly make both inferences and assumptions in order to solve the problem (that is, to transform and combine the premises so as to demonstrate the conclusion).

Rubric for this measure is enclosed as are sample assessments (Assignment 6).</td></tr>
<tr><td>Criteria for Student Success</td><td colspan="3">Students will correctly solve the proof exercises, so that they will get to the conclusion from the given premises and not make any mistakes in reasoning and very few (if any) unnecessary steps (which are steps that are logically correct but do not approach the conclusion).</td></tr>
<tr><td>Program Success Target for this Measurement</td><td>80% of students will have reached Milestone 3 in the course (earning 3-out-of-4 on the rubric), represented by 75% or higher in their grade.</td><td>Percent of Program Achieving Target</td><td>80% (two students earned 70%)</td></tr>
<tr><td>Methods</td><td colspan="3">We sampled assignments from 10 students (<i>N</i> = 33), or 33% of the students enrolled. These students were a mixture of honors and non-honors students proportional to actual honors and non-honors enrollments in the course: we had 9 honors and 24 non-honors in the course; so we sampled 3 honors students and 7 non-honors students. Students were each given a number, then a random-number generator was used to determine which students would have their assessments sampled. Grades for these students' assignments were then conferred.</td></tr>
<tr><td colspan="2">Based on your results, circle or highlight whether the program met the goal Student Learning Outcome 5.</td><td>☒ Met</td><td>☐ Not Met</td></tr>
<tr><td colspan="4">Follow-Up (Provide your timeline for follow-up. If follow-up has occurred, describe how the actions above have resulted in program improvement.)</td></tr>
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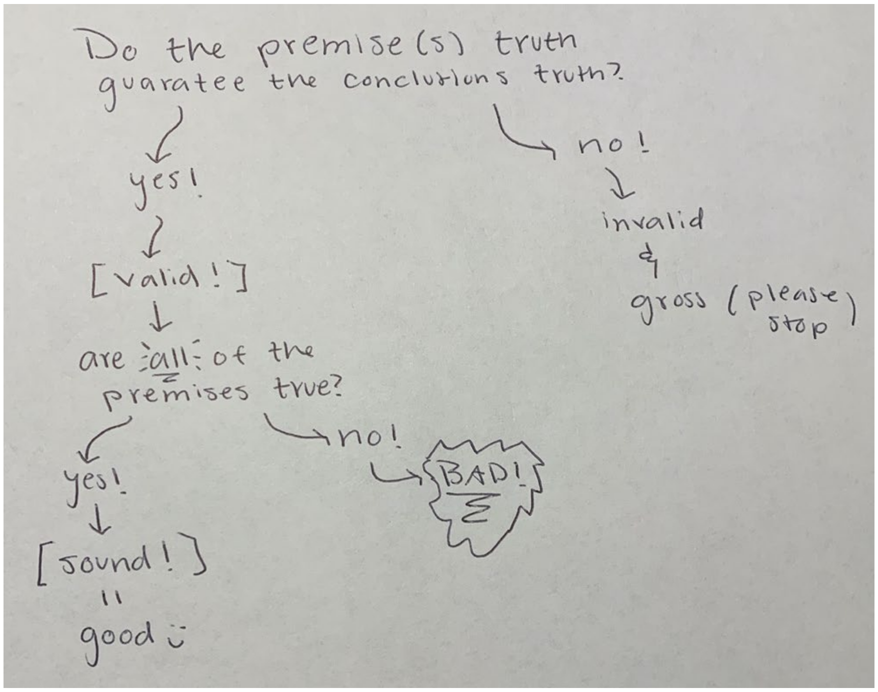
QUANTITATIVE REASONING (QR) PROPOSED SLO ASSESSMENT RUBRIC Adapted from AAC&U LEAP VALUE Rubrics (Quantitative Literacy, Problem Solving)

<table>
<tr><td colspan="5">Students will demonstrate the ability to interpret information in mathematical and/or statistical forms.</td></tr>
<tr><td></td><td>Capstone (4)</td><td>Milestone (3)</td><td>Milestone (2)</td><td>Benchmark (1)</td></tr>
<tr><td>Interpretation</td><td>Provides accurate explanations of information presented in statistical forms. Makes appropriate inferences based on that information.</td><td>Provides accurate explanations of information presented in mathematical forms.</td><td>Provides somewhat accurate explanations of information presented in mathematical forms, but occasionally makes minor errors related to computations or units.</td><td>Attempts to explain information presented in mathematical forms, but draws incorrect conclusions about what the information means.</td></tr>
<tr><td colspan="5">Students will demonstrate the ability to illustrate and communicate mathematical and/or statistical information symbolically, visually, and/or numerically.</td></tr>
<tr><td></td><td>Capstone (4)</td><td>Milestone (3)</td><td>Milestone (2)</td><td>Benchmark (1)</td></tr>
<tr><td>Representation</td><td>Skillfully converts relevant information into an insightful mathematical portrayal in a way that contributes to a further or deeper understanding.</td><td>Competently converts relevant information into an appropriate and desired mathematical portrayal.</td><td>Completes conversion of information but resulting mathematical portrayal is only partially appropriate or accurate.</td><td>Completes conversion of information but resulting mathematical portrayal is inappropriate or inaccurate.</td></tr>
</table>

Students will demonstrate the ability to determine when computations are needed and to execute the appropriate computations.				
	Capstone (4)	**Milestone (3)**	**Milestone (2)**	**Benchmark (1)**
Calculation	Calculations attempted are essentially all successful and sufficiently comprehensive to solve the problem. Calculations are also presented elegantly.	Calculations attempted are essentially all successful and sufficiently comprehensive to solve the problem.	Calculations attempted are either unsuccessful or represent only a portion of the calculations required to comprehensively solve the problem.	Calculations are attempted but are both unsuccessful and are not comprehensive.
Students will demonstrate the ability to apply an appropriate model to the problem to be solved.				
	Capstone (4)	**Milestone (3)**	**Milestone (2)**	**Benchmark (1)**
Proposes Solutions/Hypotheses	Proposes one or more solutions/hypotheses that indicate a deep comprehension of the problem. Solution/hypotheses are sensitive to contextual factors.	Proposes one or more solutions/hypotheses that indicate comprehension of the problem. Solutions/hypotheses are sensitive to contextual factors.	Proposes one solution/hypothesis that is “off the shelf” rather than individually designed to address the specific contextual factors of the problem.	Proposes a solution/hypothesis that is difficult to evaluate because it is vague or only indirectly addresses the problem statement.
Students will demonstrate the ability to make inferences, evaluate assumptions, and address limitations in estimation modeling and/or statistical analysis.				
	Capstone (4)	**Milestone (3)**	**Milestone (2)**	**Benchmark (1)**
Application/Analysis/Assumptions	Uses the quantitative analysis of data as the basis for drawing insightful conclusions. Explicitly describes appropriate assumptions and shows awareness that confidence in final conclusions is limited by the accuracy of the assumptions.	Uses the quantitative analysis of data as the basis for drawing reasonable conclusions. Explicitly describes assumptions.	Uses the quantitative analysis of data as the basis for drawing conclusions that are plausible but without inspiration or nuance. Explicitly describes assumptions	Uses the quantitative analysis of data as the basis for tentative or uncertain conclusions. Attempts to describe assumptions.

Evaluators are encouraged to assign a zero to any work that does not meet the benchmark-level performance.

1. (2 points) Draw a diagram showing the procedure for checking if an argument is good.



2. (1 point) Give an example of a valid argument that is not sound, but has a true conclusion.

1. If WKU is on a hill, then all hills have WKU's on them.
2. WKU is on a hill.
3. Therefore, all hills have WKU's on them.

3. (1 point) Give a counterexample to the validity of this argument (a counterexample has true premises and a false conclusion).

1. President Caboni is the President of WKU.
2. President Caboni has a mini mansion in Nashville.
3. So, President Caboni is a vampire.

4. (1 point) Give an example of an argument that shows why we need to distinguish the modal and formal definitions of validity.

1. Rose is a philosophy major.
2. So, Rose is 19 years old.

Both the premise and conclusion are true, but there is no structure and support to the argument. The necessarily true conclusion automatically makes it a valid argument, and yet it isn't a cohesive structure.

5. (3 points) Translate the following argument into propositional logic:

(a) (A V B)
(b) (A → B)
(c) (A → ~B)
(d) (~A & B)

6. (2 points) Identify the main connectives in the following propositional logic formulas:

* I highlighted the mc's of each PL formulas
* (c) doesn't have a mc

(a) (P & ~ Q) ↔ (~ Q → S)
(b) ~(Q ↔ ~ P)
(c) P
(d) (Q & R) & (R ∨ S)

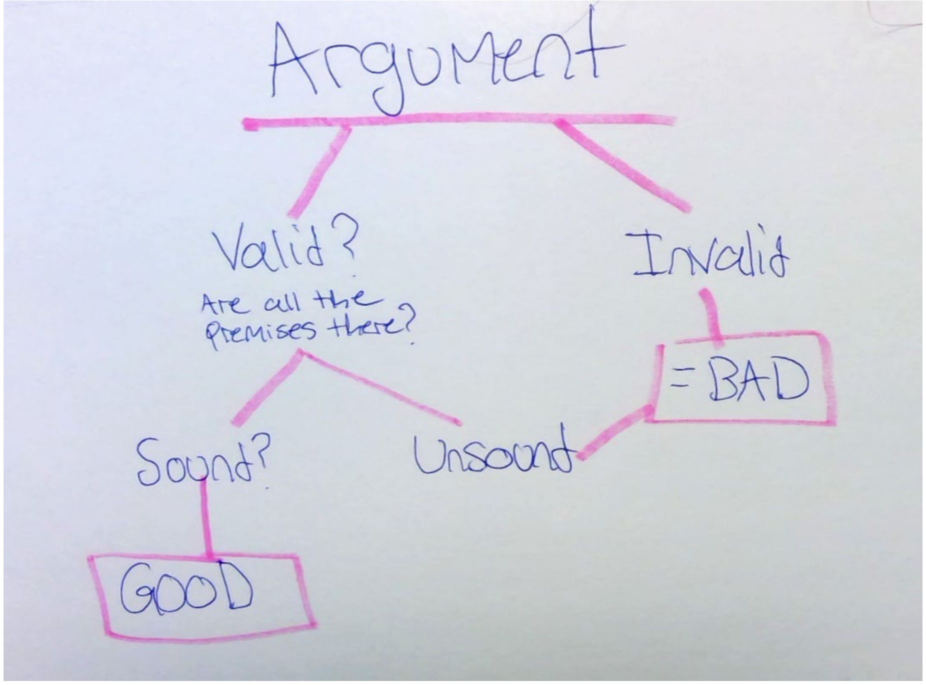
Meg Henderson

PHIL 215-002

2/4/22

Assignment 1

1.



2. If Rachel is Meg's roommate

Then, Meg is a junior in college

So, Meg is a girl

3. Meg is a human

Then, Meg can breathe

So, Meg can fly

4. Meg = Emily

So, 1 + 1 = 2

5. (a) A v B

(b) B → C

(c) C → ~B

(d) ~ (C&A)

6. (a) ↔

(b) ↔

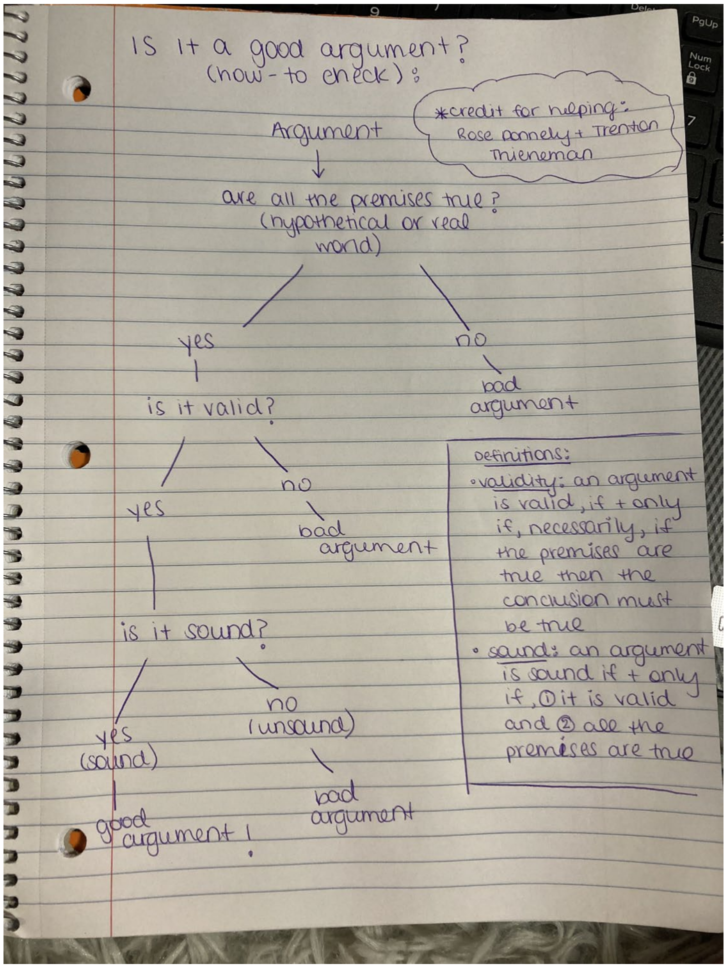
(c) No connective

(d) &

PHIL 215: Symbolic Logic

Assignment 1

1.



*credit for helping: Rose Donnely + Trenton Thieneman

Definitions:

- validity: an argument is valid, if + only if, necessarily, if the premises are true then the conclusion must be true
- sound: an argument is sound if + only if, ① it is valid and ② all the premises are true

2. An example of a valid argument that is not sound, but has a true conclusion is:

   a) All pink unicorns can hold their breath underwater.

   b) It is a pink unicorn.

   c) Therefore, it can hold its breath underwater.

3. A counterexample to the validity of an argument is:

a) If P, then Q.	a) If it is a square, then it is a rectangle.
b) Q.	b) It is a rectangle.

c) Therefore, P.   c) Therefore, it is a square.

4. An example that shows why we need to distinguish between the modal and formal definitions of validity:

1) Genevieve is five years old.

2) So, the derivative of sine is cosine.

5. Translated argument:

a) A v B.   A=I'm dead right

b) B → C.   B= I'm crazy

c) C → ~B.   C=I'll put it to a vote

d) :~B & A.

6. Identify Main Connectives:

a) (P & ~ Q) ↔ (~ Q → S)

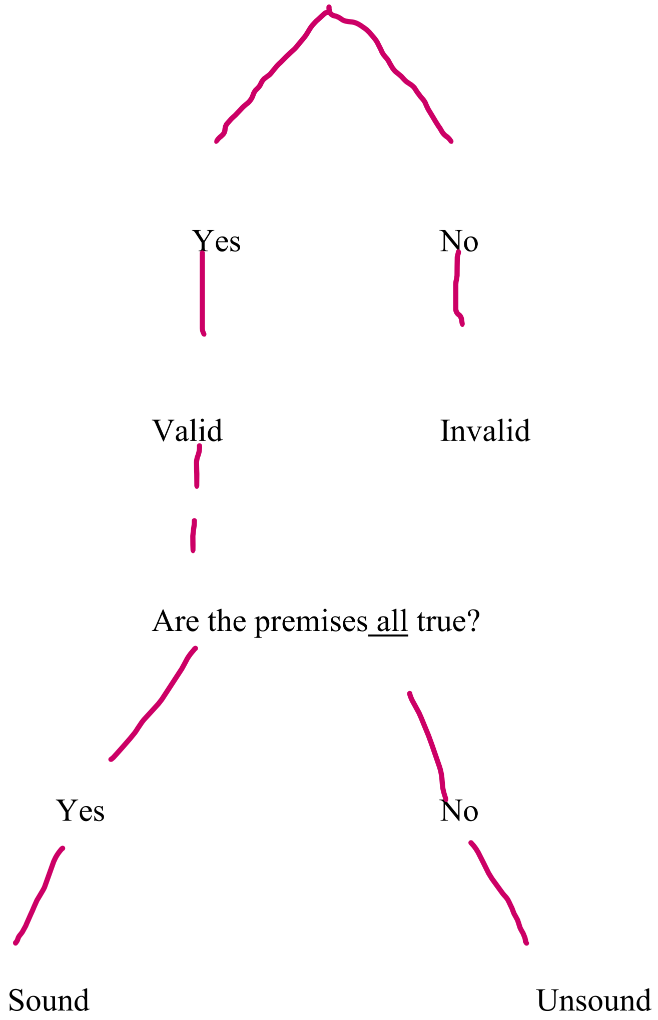
b) ~(Q ↔ ~ P)

c) P

d) (Q & R) & (R ∨ S)

Question 1:

Do the premises' truth guarantee the conclusion's truth?



Question 2:

1. If I am a student at UK, then my mascot is Big Red.
2. I am a student at UK.
3. So, my mascot is Big Red.

Question 3:

1. If I am not a WKU student, then I am not living in a dorm.

2. I am not living in a dorm.
3. So, I am not a WKU student.

Question 4:

1. The sky is blue.
2. So, Landon Elkind is my professor.

The issue with the modal form can be found with this argument, as it remains valid, even if it does not make much sense. The conclusion, “So, Landon Elkind is my professor,” has no basis in the premises, but because it is a true statement, it is modally valid. For an argument to be formally valid, the conclusion must be drawn from the premises. To discover if an argument is formally valid, you should analyze its form.

Question 5:

Key:

(i)	I’m dead right	P
(ii)	I’m crazy	Q
(iii)	Put it to a vote	R

PL:

P v Q, Q → R, R → (~Q): (~Q) & P

Question 6.

(a) ↔

(b) ~

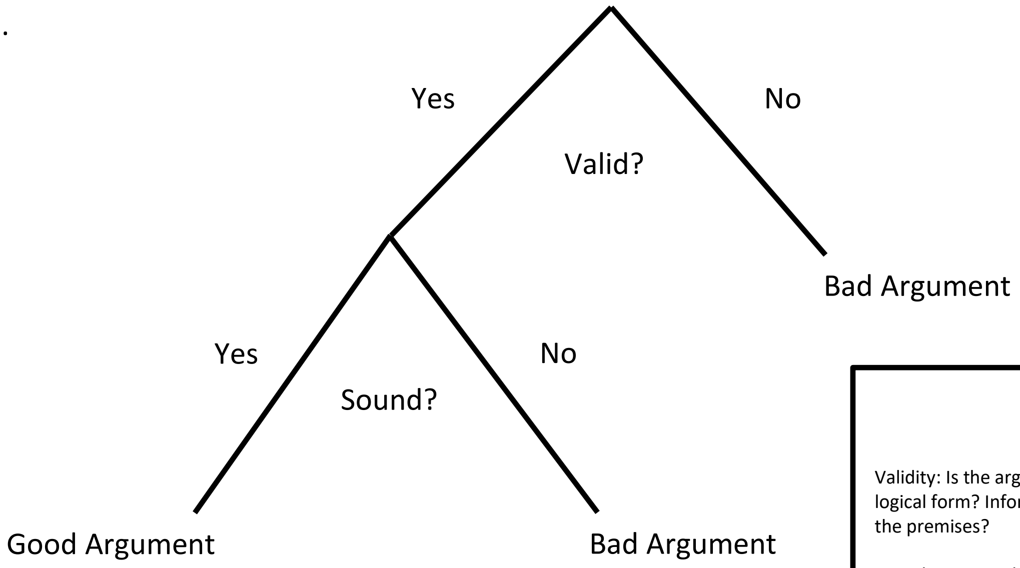
(c) None

(d) &

Ethan Huffaker

Assignment #1

1.



Key:

Validity: Is the argument a substitution-instance of a valid logical form? Informally, does the conclusion follow from the premises?

Soundness: Are the premises true (there's also a requirement of validity, but that has already been passed)?

Good Argument: Sound (soundness presupposes validity).

Bad Argument: Not Sound (could have untrue premises or could be invalid).

2.

1. If turtles are mammals, then they are also reptiles.
2. Turtles are mammals.
3. Therefore, turtles are reptiles.

3.

Given this argument,

1. If turtles are mammals, then turtles are also reptiles.
2. Turtles are amphibians.
3. Therefore, turtles are reptiles.

which has the form,

1. $P \rightarrow Q$
2. R
3. Q

One can use this counterexample to prove invalidity.

1. If George Washington is an alligator, he is a reptile.
2. George Washington is the first President of the United States.
3. Therefore, George Washington was a reptile.

Or this one:

1. If someone does something, it is done.
2. 1 + 2 = 3
3. Therefore, it is done.

Ethan Huffaker

Neither of these arguments give me proper support for the claim that “it is done” or for the claim “George Washington is a reptile”. Both are plainly not true even though the premises are true. Therefore, the argument form must be invalid since there are counterexamples to its validity.

4.

1. Mark is a human.
2. Therefore, 5 + 7 = 12

This argument has a conclusion that is necessarily true in all possible worlds, but one could argue, correctly, that although it meets the modal definition of validity, it is still not formally valid. After all, what does Mark being human have to do with truths about the addition of two quantities of certain sizes? There seems to be no support between the premise and the conclusion at all since they are two wholly unrelated sentences.

To avoid such problems that come from the more intuitive modal definition, we can define validity formally. The formal definition, as defined by Tomassi in *Logic,* is as follows: an argument is valid if and only if it is a substitution-instance of a valid logical form. In short, if you were to create an argument with the same form whose premises are all true but which has a false conclusion, that argument form, and therefore, all arguments of that form, would be formally invalid. This is called a counterexample. Here’s one for the above argument that proves that the argument is formally invalid.
The form is:

1. P
2. Therefore, Q

A counterexample (a substitution-instance of the logical form in which a false conclusion follows from true premises) is:

1. 2 + 2 = 4
2. Therefore, Bigfoot is the governor of Louisiana.

Bigfoot is not the governor of Louisiana even though 2 + 2 = 4. Clearly, the support relationship in this argument does not guarantee the conclusion’s truth.

5.

a. $P \vee Q$
b. $Q \rightarrow R$
c. $R \rightarrow {\sim}Q$
d. $P \,\&\, {\sim}Q$

AKA: $P \vee Q,\ Q \rightarrow R,\ R \rightarrow {\sim}Q : P \,\&\, {\sim}Q$

6.

a. ↔
b. ~
c. N/A
d. &

Mary Huther

Mr. Elkind

February 8th

PHIL 215-002

Assignment 1 Landon D. C. Elkind PHIL 215: Symbolic Logic

Please answer the questions below, writing no more than three double-spaced pages total:

1. (2 points) Draw a diagram showing the procedure for checking if an argument is good.

   Do the premises truth guarantee the conclusions truth?

   If yes: valid **If no: Invalid**

   If it is Valid, are all the premises true?

   If yes: sound **If no: Unsound**

2) (1 point) Give an example of a valid argument that is not sound but has a true conclusion.
   a. **Craig is a Scot**
   b. **All Scots are dumb**
   c. **Craig is dumb**

3. (1 point) Give a counterexample to the validity of this argument (a counterexample has true premises and a false conclusion).

a. Landon likes chocolate ice cream

b. Landon likes vanilla ice cream

c. So, Landon is a worm

4. (1 point) Give an example of an argument that shows why we need to distinguish the modal and formal definitions of validity.

   a. Landon is a wooden desk

b. 2+4=6
we need to have a model that distinguishes the definitions because obviously these two points have nothing to do with each other, but because the conclusion is technically correct, this is valid.

5. (3 points) Translate the following argument into propositional logic:

(a) Either I’m dead right or I’m crazy.

(b) If I’m crazy, then I’ll put it to a vote.

(c) If I put it to a vote, then I’m not crazy.

(d) So, I am not crazy, and I am dead right.

a. P v Q

b. Q -> S

c. S -> R

d. R & P

6. (2 points) Identify the main connectives in the following propositional logic formulas:

(a) (P & ~ Q) ↔ (~ Q → S)

(b) ~(Q ↔ ~ P)

(c) P

(d) (Q & R) & (R ∨ S)

a. the main connective is “←> if an only if”

b. the main connective is “~ not”

c. the main connective is ?

d. the main connective is “& and”

1. Do the premises truth guarantee the conclusions truth?
    a. If yes- Valid
    b. If no- Invalid
        i. If valid- Are all the premises true?
            1. If yes- Sound argument (good argument)
            2. If no- unsound argument
2. If Trent is a dog, Trent is a human

    Trent is a dog

    Therefore, Trent is a human.
3. Dogs are animals and mammals

    Therefore, all animals are mammals
4. The sky is blue

    Therefore, 2+2=4

    We need a modal and formal definition of validity for examples such as this. If we use the modal definition of validity this is a valid argument, however we know that this is not the case when we break it down to its argument form. Formal definition of validity can help us to ensure arguments are valid, beyond the truth test.
5. 1. D v C

    2. C → V

    3. V → (~C)

    4. : (~C) & D

6. A. ↔

B. ~

C. No connective

D. &

Seth Nevin

PHIL 215

Dr. Elkind

February 4th, 2022

Assignment #1

Please answer the questions below, writing no more than three double-spaced pages total:

1. (2 points) Draw a diagram showing the procedure for checking if an argument is good.

Do the premises truth guarantee the conclusions truth?
If yes, then it is Valid.   If no, then it is Invalid.

Are the premises all true?

If Yes, then it is Sound, if No, it is unsound.

2. (1 point) Give an example of a valid argument that is not sound, but has a true conclusion.

1. If Ruffus is a lizard, then he is a mammal.

2. Ruffus is a lizard.

3. Therefore, Ruffus is a lizard.

3. (1 point) Give a counterexample to the validity of an argument (a counterexample has true premises and a false conclusion).

1. Seth has 2 arms.

2. Therefore, Seth is a cryptid.

1. A

2. So, R.

4. (1 point) Give an example of an argument that shows why we need to distinguish the modal and formal definitions of validity.

1. It is necessary for me to pay my rent.

2. There is a world where I fail to pay it.

Modally speaking, this is valid.

1. All bachelors are unmarried.

Formally speaking, this is valid.

5. (3 points) Translate the following argument into propositional logic:
(a) Either I'm dead right or I'm crazy.
(b) If I'm crazy, then I'll put it to a vote.
(c) If I put it to a vote, then I'm not crazy.
(d) So, I am not crazy and I am dead right.

(a) R v C

(b) C → V

(c) V → ~C

(d) ~C & R

6. (2 points) Identify the main connectives in the following propositional logic formulas:
(a) (P & ~ Q) ↔ (~ Q → S)
(b) ~(Q ↔ ~ P)
(c) P
(d) (Q & R) & (R v S)

(a) ↔ "if and only if"

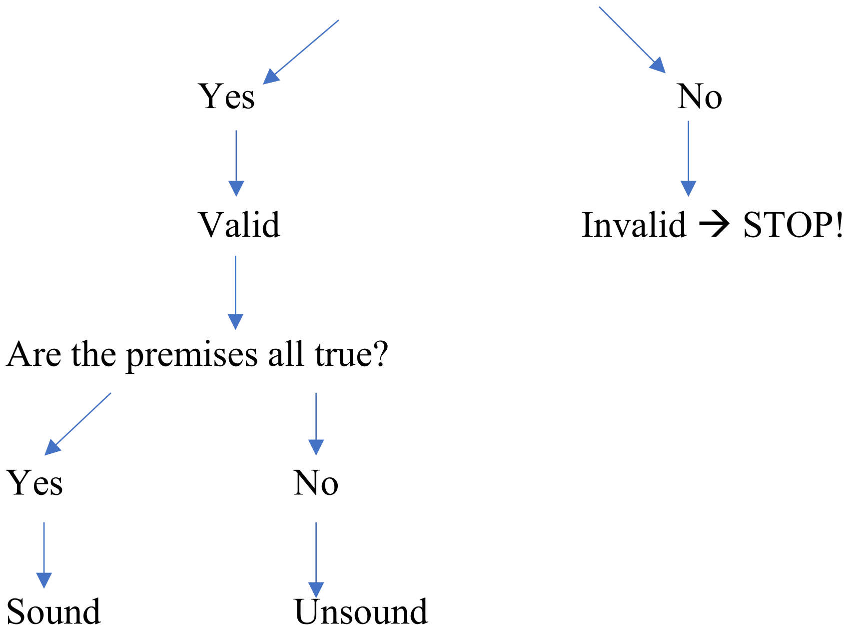
(b) ~ "it is not the case that..."

(c) no connective, as the formula is just "P"

(d) & "and"

PHIL 215 ASSIGNMENT 1

1. Do the premises' truth guarantee the conclusions truth?



2. Give an example of a valid argument that is not sound but has a true conclusion.
    a. If WKU is located in Bowling Green, KY
    b. They are a part of the South Eastern Conference (SEC) [not true]
    c. Therefore, WKU beat Ole Miss in men's basketball earlier this season
3. Give a counterexample to the validity of an argument (a counterexample has true premises and a false conclusion).
    a. If WKU is located in Bowling Green, KY
    b. Their mens basketball team beat Ole Miss's basketball team
    c. Therefore, WKU will go undefeated in basketball until the end of time (or the basketball program, whichever comes first)

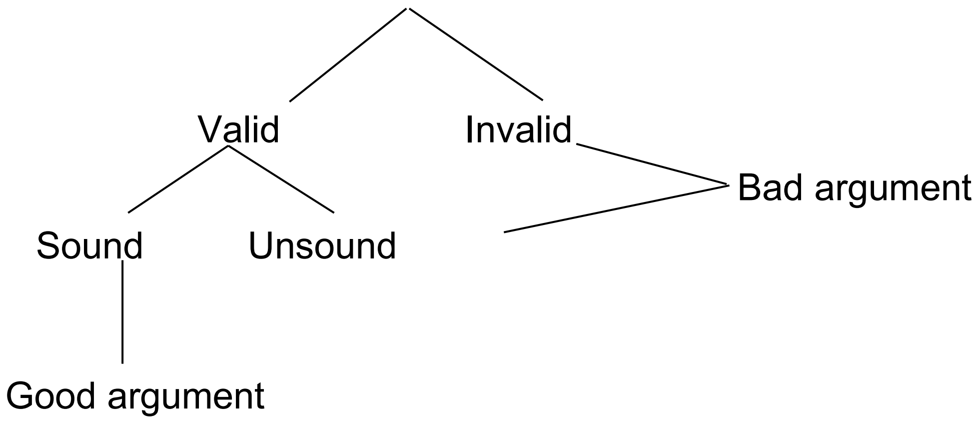
Would this be a better alternative to q. 3?

- A. Avery is a college student
- B. She is a philosophy major
- C. Therefore, she will graduate with a Bachelors in Science

4. Give an example of an argument that shows why we need to distinguish the modal and formal definitions of validity.
    a. We need to distinguish between the modal and formal definitions of validity because "the claim on the formal logician is that an argument is valid purely in virtue of being a *substitution-instance* of a valid argument form" (Tomassi Box 1.1, pg. 26). The modal definition,

according to Tomassi, is “not an entirely accurate one … because it refers to the notion of necessity” (Tomassi, 11). The modal definition to validity “refers to the notion of necessity, the “must” element” (Tomassi, 11). The formal definition to validity isn’t necessarily concerned with the content of the argument, it doesn’t really matter what you are trying to argue as long as the form of the argument is correct (Tomassi, 10). It is important to distinguish between the modal and the formal definitions of validity because if one definition isn’t entirely accurate, then the entire argument has the possibility to be wrong.

5. Translate the following argument into propositional logic:
    a. Either I’m dead right or I’m crazy
    b. If I’m crazy, then I’ll put it to a vote
    c. If I put it to a vote, then I am not crazy
    d. So, I am not crazy and I am dead right
        i. Translation:
            1. R v C
            2. C → V
            3. V→ ~ C
            4. So, ~ C & R
6. Identify the main connectives in the following propositional logic formulas:
    a. (P & ~ Q) ↔ (~ Q → S)
    b. ~ (Q ↔ ~ P)
    c. P
    d. (Q & R) & (R v S)
        i. ↔
        ii. &



1.
2.
   a. If Michaela is an apple, then Michaela is a student.
   b. Michaela is an apple.
   c. So, Michaela is a student.
3.
   a. An apple is a fruit.
   b. So, bananas are coconuts.
      This is a counterexample for an argument of the form
      P
      So, Q.
4. The following argument shows the need to distinguish between the formal and modal definitions of validity:
   a. This is a logic class.
   b. Therefore, 2 is a number.

   Despite the premise being completely unrelated to the conclusion, the argument is valid irregardless because the conclusion is always true. Thus, the formal definition is needed so that the concept of argument-form is considered when determining if an argument is valid or not.
5.
   a. A v B
   b. B→Q
   c. Q→~B
   d. So, ~B&A.
6.
   a. ↔
   b. ~
   c. There is no connective.
   d. ^

① $(P \& P) \vdash (Q \to Q) \leftrightarrow P$

$(P \& P)$

$\sim [(Q \to Q) \leftrightarrow P]$

|

P

Q

/ \

$\sim(Q \to Q)$ $(Q \to Q)$

P $\sim P$

| X

Q

$\sim Q$

X

Valid!

---

② $\vdash (\sim(Q \to R) \to \sim P) \to (\sim R \to \sim Q)$

$\sim[(\sim Q \to R) \to \sim P) \to (\sim R \to \sim Q)$

$(\sim(Q \to R) \to \sim P)$

$\sim[(\sim R \to \sim Q)]$

|

$\sim R$

$\sim\sim Q$

|

Q

/ \

$\sim\sim(Q \to R)$ $\sim P$

|

$(Q \to R)$

/ \

$\sim Q$ R

X X

Invalid

IPLI:

Q = False

R = False

P = True

P = The sky is blue.

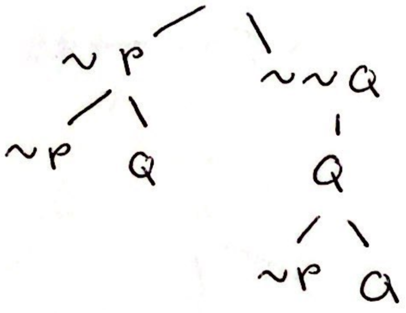
Q = Real grass is always purple.

R = Landon doesn't have a BlackBerry phone.

⑤ $\sim(P \& \sim Q) \vdash \sim(P \to Q)$

$\sim(P \& \sim Q)$ ✓

$\sim\sim(P \to Q)$ ✓



<u>Invalid</u>

IPLI:

P = False

Q = True

P = Rose didn't go to the KPA

Q = Dr. Anton has a dog named Thea.

---

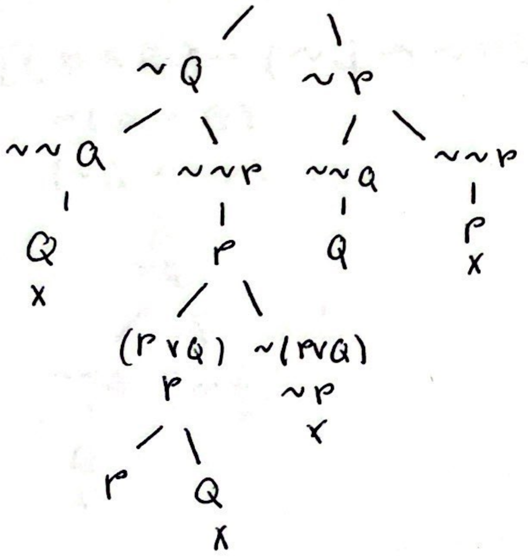
⑥ $(P \vee Q) \leftrightarrow P \vdash (Q \& P) \vee (\sim Q \& \sim P)$

$(P \vee Q) \leftrightarrow P$

$\sim[(Q \& P) \vee (\sim Q \& \sim P)]$

$\sim(Q \& P)$

$\sim(\sim Q \& \sim P)$



<u>Invalid</u>

IPLI:

P = True

Q = False

P = getting sand in your eyes hurts.

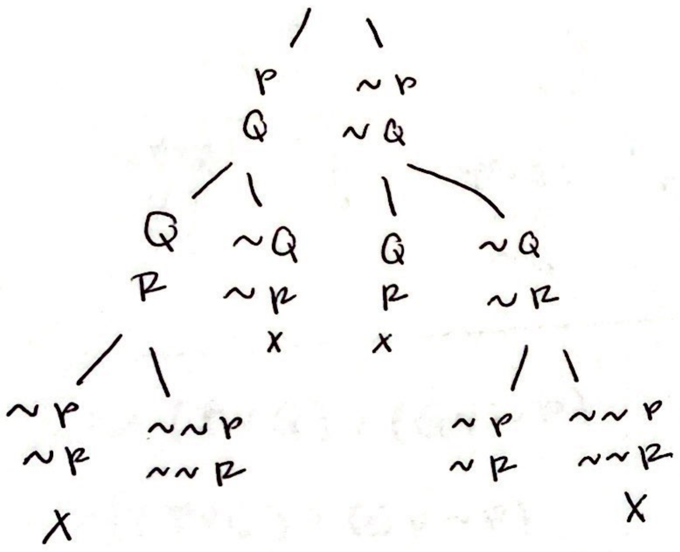
Q = Dr. Elkind is an undercover CIA agent.

⑦ $(P \leftrightarrow Q), (Q \leftrightarrow R) \vdash \sim P \leftrightarrow \sim R$

$(P \leftrightarrow Q)$ ✓

$(Q \leftrightarrow R)$ ✓

$\sim[\sim P \leftrightarrow \sim R]$ ✓



Invalid

IPLI:

P = False

Q = False

R = False

P = The~~re~~ 2020 pres. election ~~was~~ was "stolen" from trump

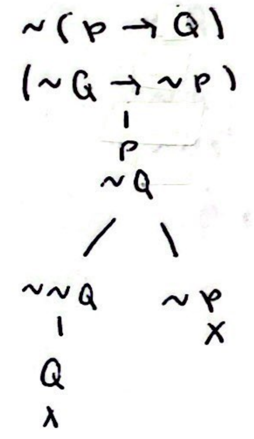
Q = The earth is flat

R = Mew-mew isn't a good cat.

---

⑧ $\vdash (P \rightarrow Q) \rightarrow (\sim Q \rightarrow \sim P)$

$\sim[(P \rightarrow Q) \rightarrow (\sim Q \rightarrow \sim P)$



True!

③ $(P \vee Q) \rightarrow R \vdash (P \rightarrow R) \& (Q \rightarrow R)$

$(P \vee Q) \rightarrow R$

$\sim[(P \rightarrow R) \& (Q \rightarrow R)]$

$\sim(P \rightarrow R)$ $\sim(Q \rightarrow R)$

P Q

$\sim R$ $\sim R$

$\sim(P \vee Q)$ R x $\sim(P \vee Q)$ R x

$\sim P$ $\sim P$

$\sim Q$ $\sim Q$

Invalid

IPLI:

P = False

Q = False

R = False

P = Tim Caboni is an eel.

Q = Tomassi is still alive.

R = All people are lizards.

---

④ $\vdash (P \vee Q) \vee (Q \vee \sim P)$

$\sim[(P \vee Q) \vee (Q \vee \sim P)$

$\sim(P \vee Q)$

$\sim(Q \vee \sim P)$

$\sim P$

$\sim Q$

$\sim Q$

$\sim\sim P$

P x

Invalid

P = False

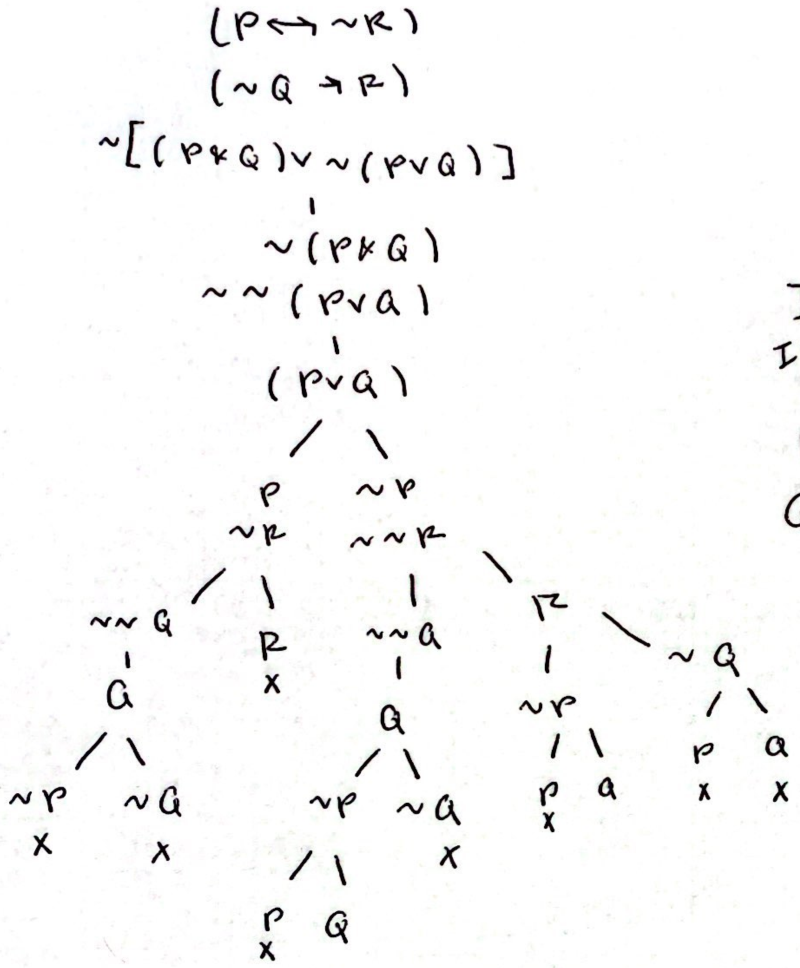
Q = False

IPLI:

P = The WKU buses <u>always</u> run on time.

Q = Birds are real & Regan didnt replace them.

⑨ $(P \leftrightarrow \sim R), (\sim Q \rightarrow R) \vdash (P \& Q) \vee \sim(P \vee Q)$



Invalid

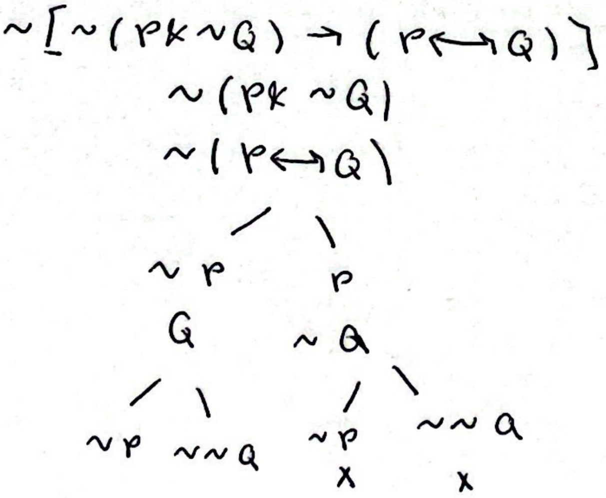
IPLI
P = False
R = True
Q = True

P = Brushing your teeth is bad.

R = Dr. Elkind has a child named Eliza.
↓
I'm sorry if I didn't spell her name correctly

Q = Dr. Seidler is the oldest philosophy professor currently at WKU.

⑩ $\vdash \sim(P \& \sim Q) \rightarrow (P \leftrightarrow Q)$



Invalid

P = False

Q = True

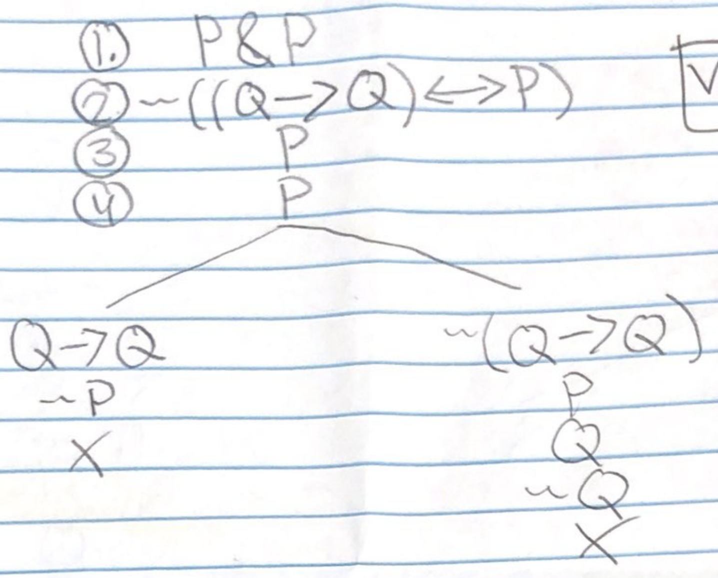
P = Dr. Elkind enjoys playing wordle.

Q = Harry Potter is a wizard.

Meg Henderso

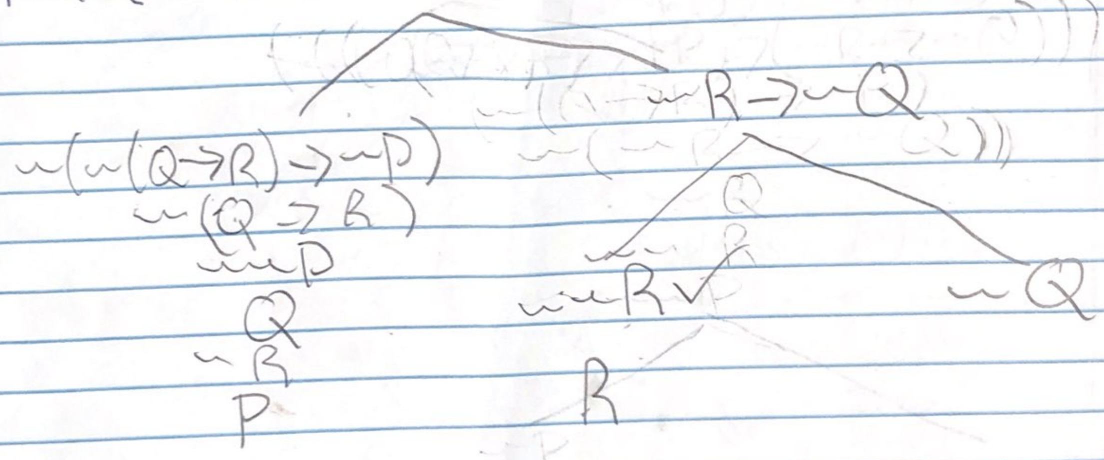
Assignment 3 : PHIL 215

(1) $P \& P \vdash (Q \rightarrow Q) \leftrightarrow P$



VALID

(2) $\vdash (\sim(Q \rightarrow R) \rightarrow \sim P) \rightarrow (\sim R \rightarrow \sim Q))$



INVALID

Q = T
R = F
P = F

(3). $(P \vee Q) \to R \vdash (P \to R) \,\&\, (Q \to R)$

① $(P \vee Q) \to R$

② $\sim((P \to R) \,\&\, (Q \to R))$

VALID

$\sim(P \to R)$

P

$\sim R$

$\sim(P \vee Q)$

$\sim P$

$\sim Q$

X

R

X

$\sim(Q \to R)$

Q

$\sim R$

$\sim(P \vee Q)$

$\sim P$

$\sim Q$

X

R

X

(4) $\vdash (P \vee Q) \vee (Q \vee \sim P)$

$\sim((P \vee Q) \vee (Q \vee \sim P))$

$\sim(P \vee Q)$

$\sim(Q \vee \sim P)$

$\sim Q$

$\sim\sim P$

P

$\sim P$

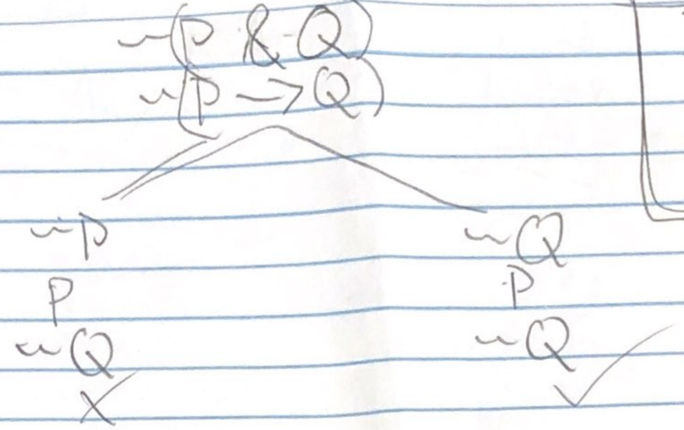
$\sim Q$

X

VALID

P=F
Q=T

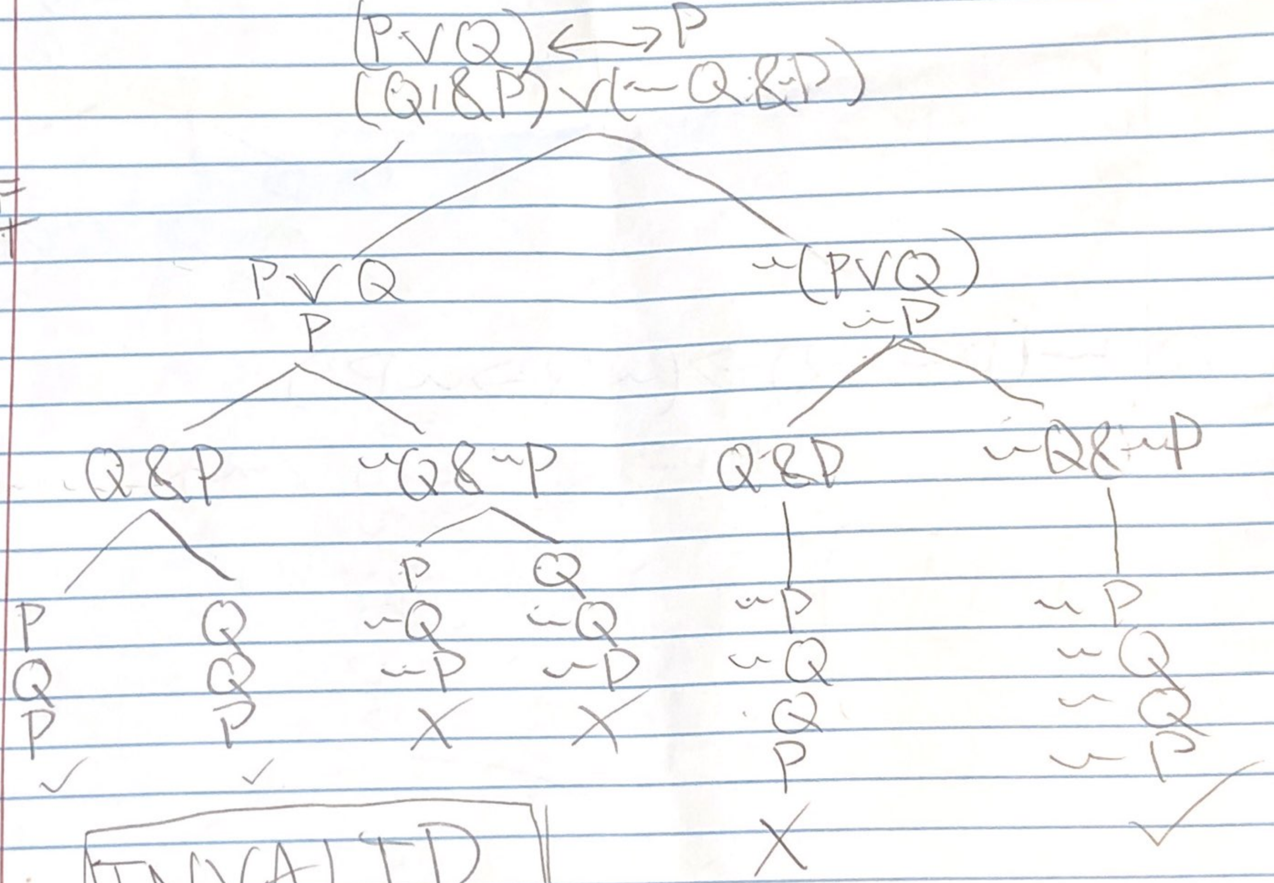
(5) ~(P&~Q) ⊢ ~(P→Q)



INVALID
P = F
Q = T

(6) (P∨Q)↔P ⊢ (Q&P)∨(~Q&~P)

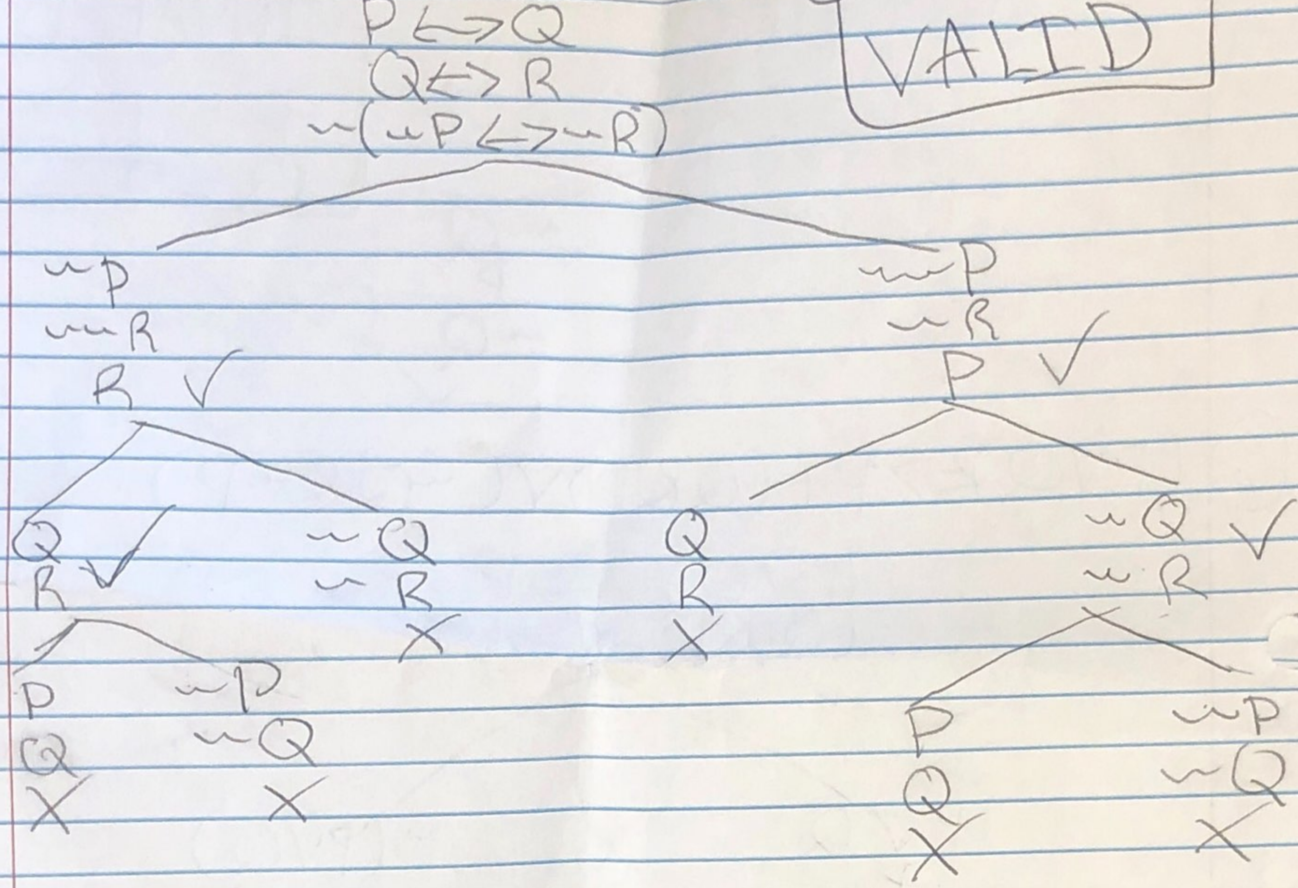
Q=F
P=T



INVALID
Q = F
P = T

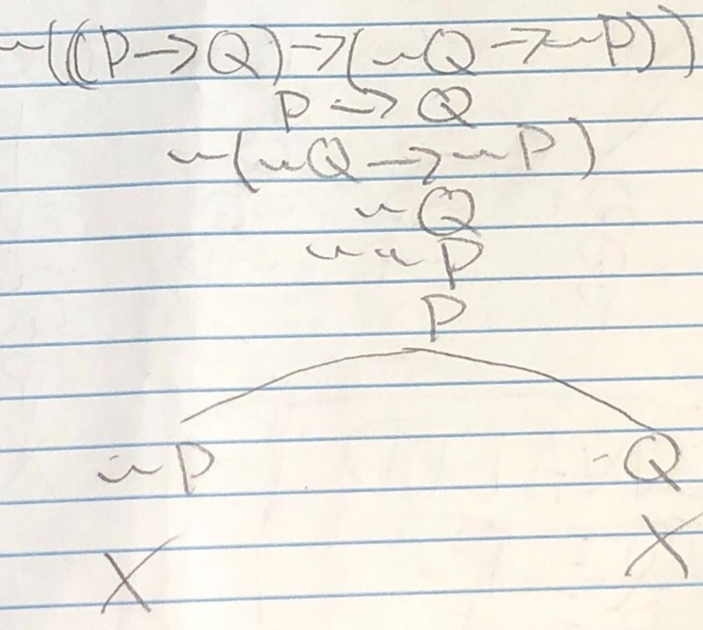
(7) P⟷Q, Q⟷R ⊢ ~P ⟷ ~R

VALID



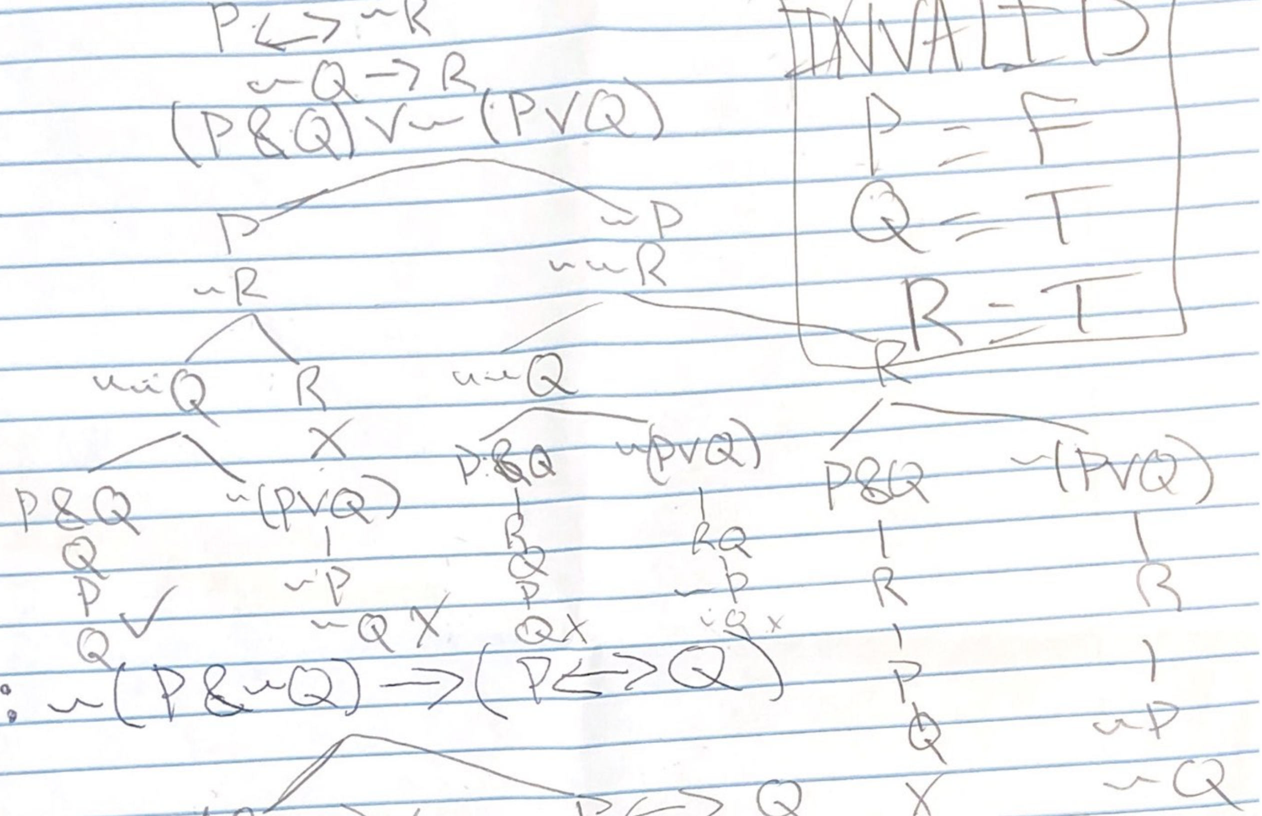
(8) ⊢ (P → Q) → (~Q → ~P)

VALID



(9) $P \leftrightarrow \sim R, \sim Q \rightarrow R \therefore (P \& Q) \vee \sim(P \vee Q)$

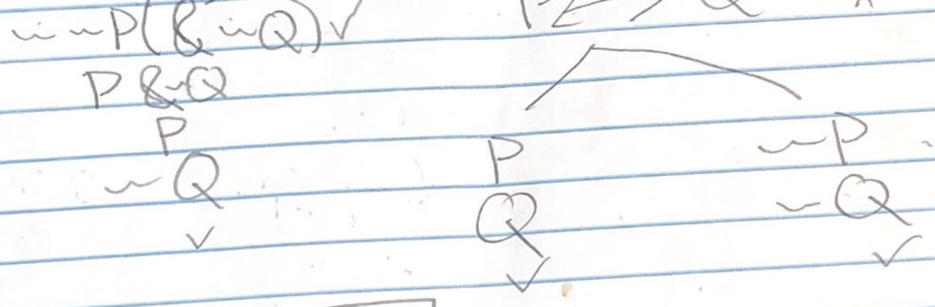
P=F
Q=T
R=T



INVALID
P = F
Q = T
R = T

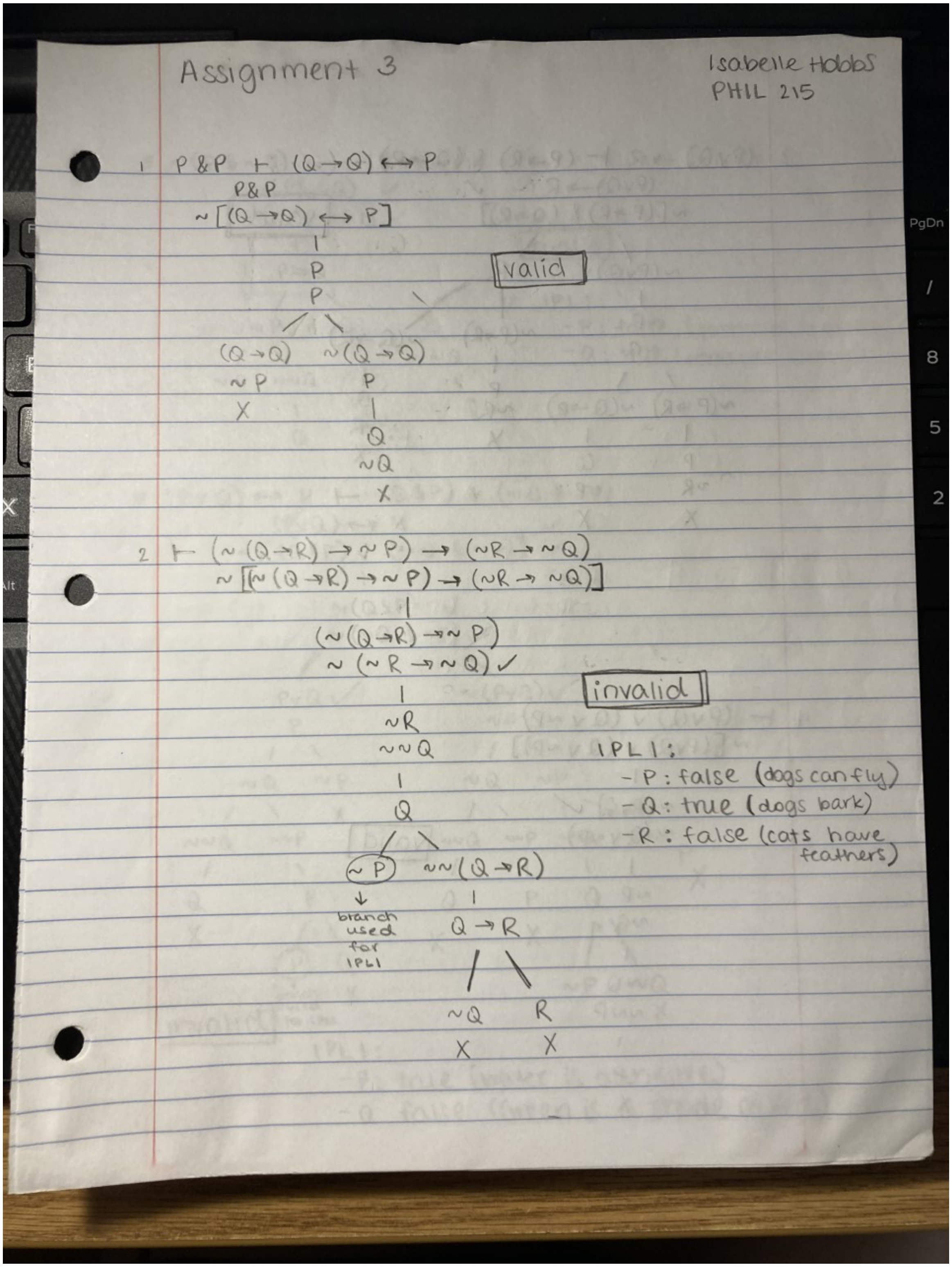
(10) $\therefore \sim(P \& \sim Q) \rightarrow (P \leftrightarrow Q)$

P=F
Q=T



INVALID
P=F
Q=T

PHIL 215: Propositional Logic
Assignment 3
Isabelle Hobbs, ID: 801537488



Assignment 3

Isabelle Hobbs
PHIL 215

1 $P \& P \vdash (Q \to Q) \leftrightarrow P$

$P \& P$
$\sim[(Q \to Q) \leftrightarrow P]$
P
P
$(Q \to Q)$ | $\sim(Q \to Q)$
$\sim P$ | P
X | Q
$\sim Q$
X

valid

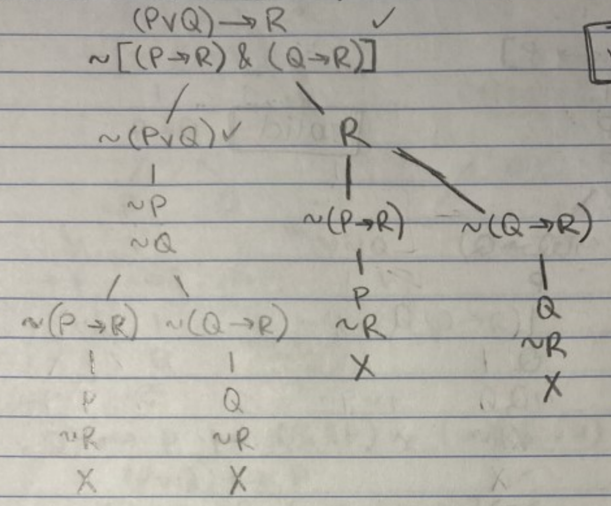
2 $\vdash (\sim(Q \to R) \to \sim P) \to (\sim R \to \sim Q)$

$\sim[(\sim(Q \to R) \to \sim P) \to (\sim R \to \sim Q)]$
$(\sim(Q \to R) \to \sim P)$
$\sim(\sim R \to \sim Q)$ ✓
$\sim R$
$\sim\sim Q$
Q
$\sim P$ | $\sim\sim(Q \to R)$
branch used for IPL1 | $Q \to R$
$\sim Q$ | R
X | X

invalid

IPL1:
- P: false (dogs can fly)
- Q: true (dogs bark)
- R: false (cats have feathers)

3 $(P \vee Q) \rightarrow R \vdash (P \rightarrow R) \& (Q \rightarrow R)$



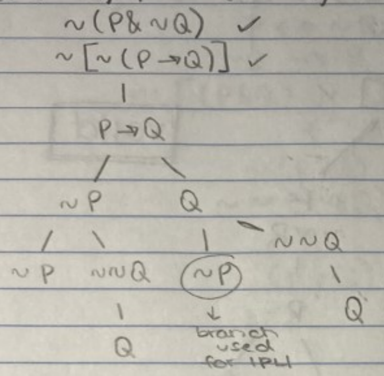
valid

4 $\vdash (P \vee Q) \vee (Q \vee \sim P)$

$\sim[(P \vee Q) \vee (Q \vee \sim P)]$
|
$\sim(P \vee Q)$ ✓
$\sim(Q \vee \sim P)$
|
$\sim P$
$\sim Q$
|
$\sim Q$
$\sim\sim P$
|
P
X

valid

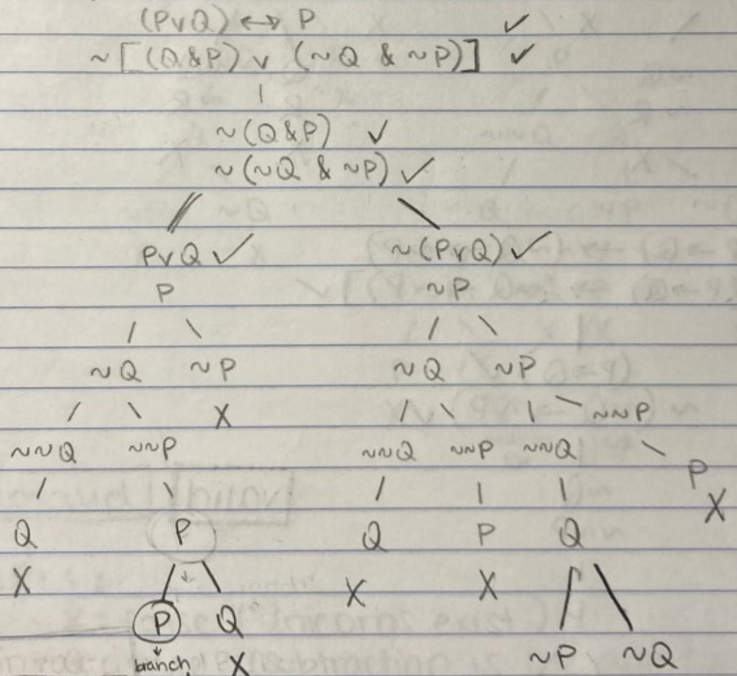
5 ~(P & ~Q) ⊢ ~(P→Q)



invalid

IPLI:
- P: false (butter is healthy)
- Q: true (worms are slimy)

6 (PvQ) ↔ P ⊢ (Q&P) v (~Q & ~P)



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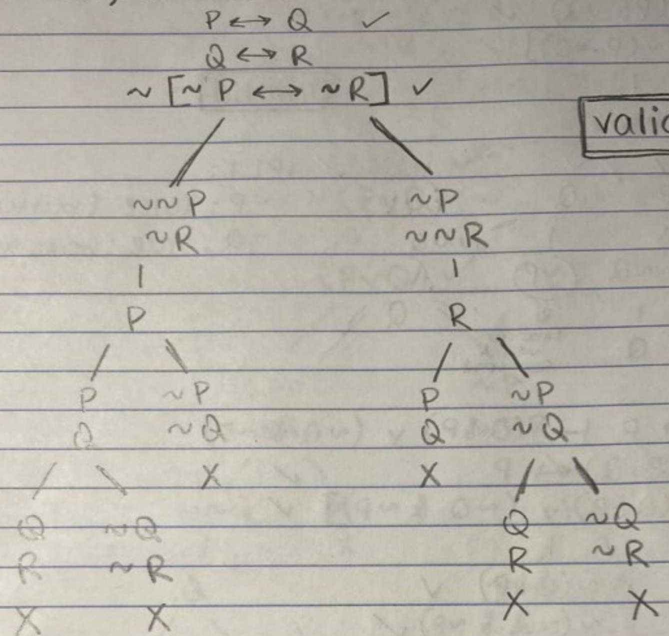
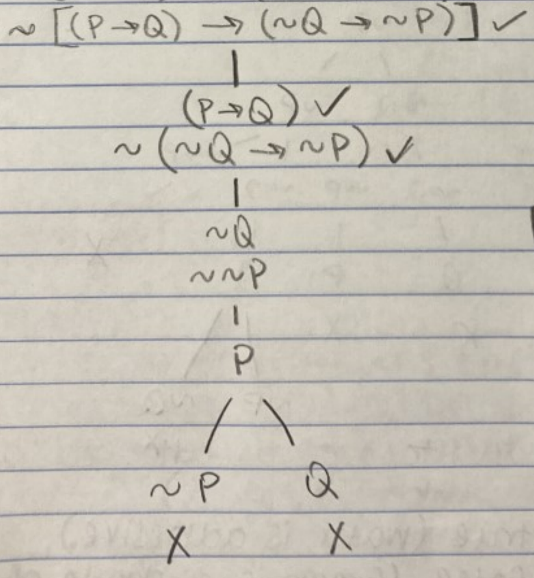
IPLI:
- P: true (water is adhesive)
- Q false (Green is a shade of red.)

7 $P \leftrightarrow Q,\ Q \leftrightarrow R \vdash \sim P \leftrightarrow \sim R$



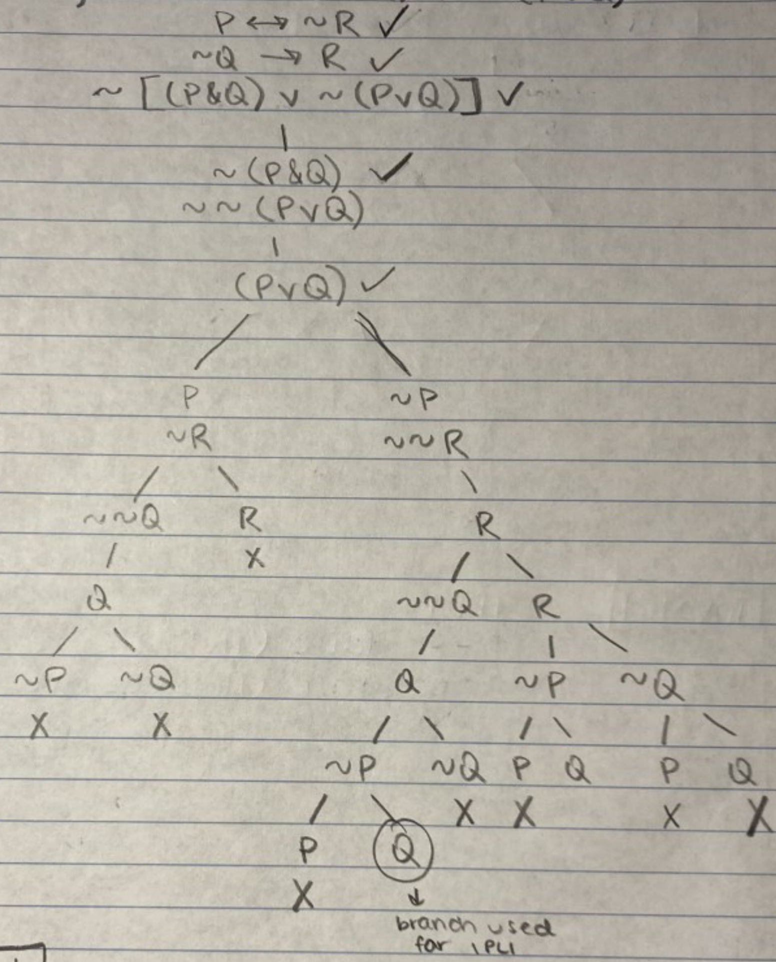
valid

8 $\vdash (P \rightarrow Q) \rightarrow (\sim Q \rightarrow \sim P)$



valid

9 P↔~R, ~Q→R ∴ (P&Q) v ~(PvQ)



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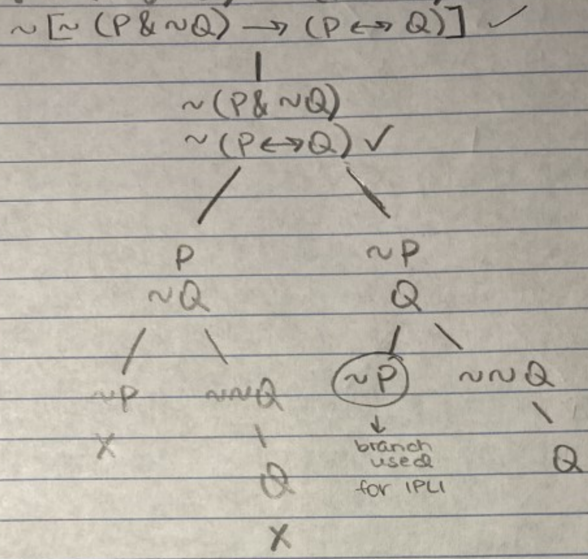
IPLI:

- P: false (unicorns exist.)
- Q: true (subtraction is the addition of negatives.)
- R: true (Pearl Harbor was attacked on December 7, 1941.)

10 : $\sim(P \,\&\, \sim Q) \rightarrow (P \leftrightarrow Q)$



$\boxed{\text{invalid}}$

IPLI :

- P : false (Hotdogs are tacos.)
- Q : true (Hotdogs are sandwiches.)

1. P & P ⊢ (Q → Q) ⟷ P

P & P

~((Q->Q) <->P)

|

P

P

/ \

~(Q->Q) Q->Q

P ~P

| X

~Q

Q

X

2. ⊢ (~(Q→R)→~P)→(~R→~Q))

~((~(Q->R)->~P)->(~R->~Q)))

/ \

~(Q->R)->~P ~(~R->~Q)

/ \ |

~(Q->R) ~~P ~R

| | ~~Q

Q P |

~R Q

ILPI:

R = False

P = True

Q = True

R = Dogs are reptiles

P = Lizards are reptiles

Q = Snakes are reptiles

3. (P ∨ Q)→R ⊢ (P →R) & (Q→R)

(P ∨ Q)→R

~((P →R) & (Q→R))

/ \

~(P->R) ~(Q->R)

| |

P Q

~R ~R

/ \ / \

~(PvQ) R ~(PvQ) R

| X | X

~P ~P

~Q ~Q

X X

4. ⊢ (P ∨ Q) ∨ (Q ∨ ~P)

~((P v Q) v (Q v ~P)

|

~(P v Q)

~(Q v ~P)

|

~P

~Q

|

~Q

~~P

|

P

X

5. ~(P & ~Q) ⊢ ~(P →Q)

~(P & ~Q)

~~(P -> ~Q)

|

P->~Q

/ \

~P ~Q

/ \ / \

~P ~~Q ~P ~~Q

| |

Q Q

X

IPLI:

P = False

Q = True

P = The sun is cold

Q = The moon is spherical

6. (P ∨ Q)⟷P ⊢ (Q & P) ∨ (~Q & ~P)

(P v Q) <-> P

~((Q & P) v (~Q & ~P))

|

~(Q&P)

~(~Q&~P)

/ \

~P ~Q

/ \ / \

~~Q ~~P ~~Q ~~P

| | | |

Q P Q P

/ \ X X / \

P v Q ~(P v Q) P v Q ~(P v Q)

P ~P P ~P

/ \ | / \ X

P Q ~P P Q

~Q

X

ILPI:

P = True

Q = False

P= Fireworks are loud

Q = Rockets are quiet

7. $P \leftrightarrow Q, Q \leftrightarrow R \vdash \sim P \leftrightarrow \sim R$

P <-> Q

Q <-> R

~(~P<->~R)

/ \

~P ~~P

~~R ~R

| |

R P
| |

Q ~Q

P ~P

/ \ / \

Q ~Q Q ~Q
R ~R R ~R

/ \ / \ / \ / \

P ~P P ~P P ~P P ~P

Q ~Q Q ~Q Q ~Q Q ~Q

X X X X X X X X

8. ⊢ (P →Q)→(~Q→~P)

~((P->Q)->(~Q->~P)

|

P->Q

~(~Q->~P)

|

~Q

~~P

|

P

/ \

~P Q

X X

9. P ↔~R,~Q→R : (P&Q) V ~(P V Q)

P <-> ~R

~Q -> R

~((P & Q) v ~(P v Q))

|

~(P & Q)

~~(P v Q)

|

P v Q

/ \

P Q

/ \ / \

```
     ~P        ~Q        ~P         ~Q
      X      /      \      /       \   X
          P      ~P       P      ~P
      ~R       ~~R    ~R         ~~R
    /    \       |     X            |
~~Q       R      R                 R
   |      X      X                /      \
   Q                           ~~Q        R
   X                              |
                                 Q
```

IPLI:

Q = True

R = True

P = False

Q = The ocean is blue

R = The Sahara Desert is full of sand

P = The Amazon Forest has no trees

10. : ~(P & ~Q)→(P ↔Q)

```
     ~(~(P&~Q)->(P<->Q))
                  |
             ~(P&~Q)
             ~(P<->Q)
           /              \
        ~P                 P
        Q                ~Q
     /         \     /           \
 ~P          ~~Q  ~P          ~~Q
                |     X            |
                Q                 Q
```

X

IPLI:

P = False

Q = True

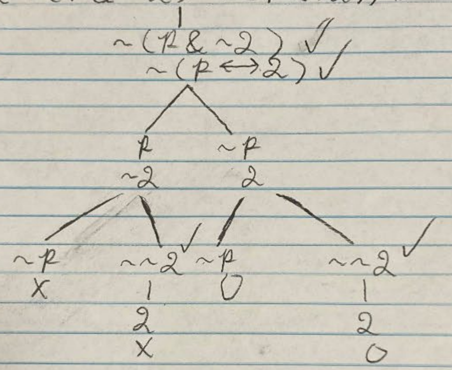
____

Water is unhealthy

Fried chicken is healthy

Ethan Huffaker assignment # 3 3/21/22

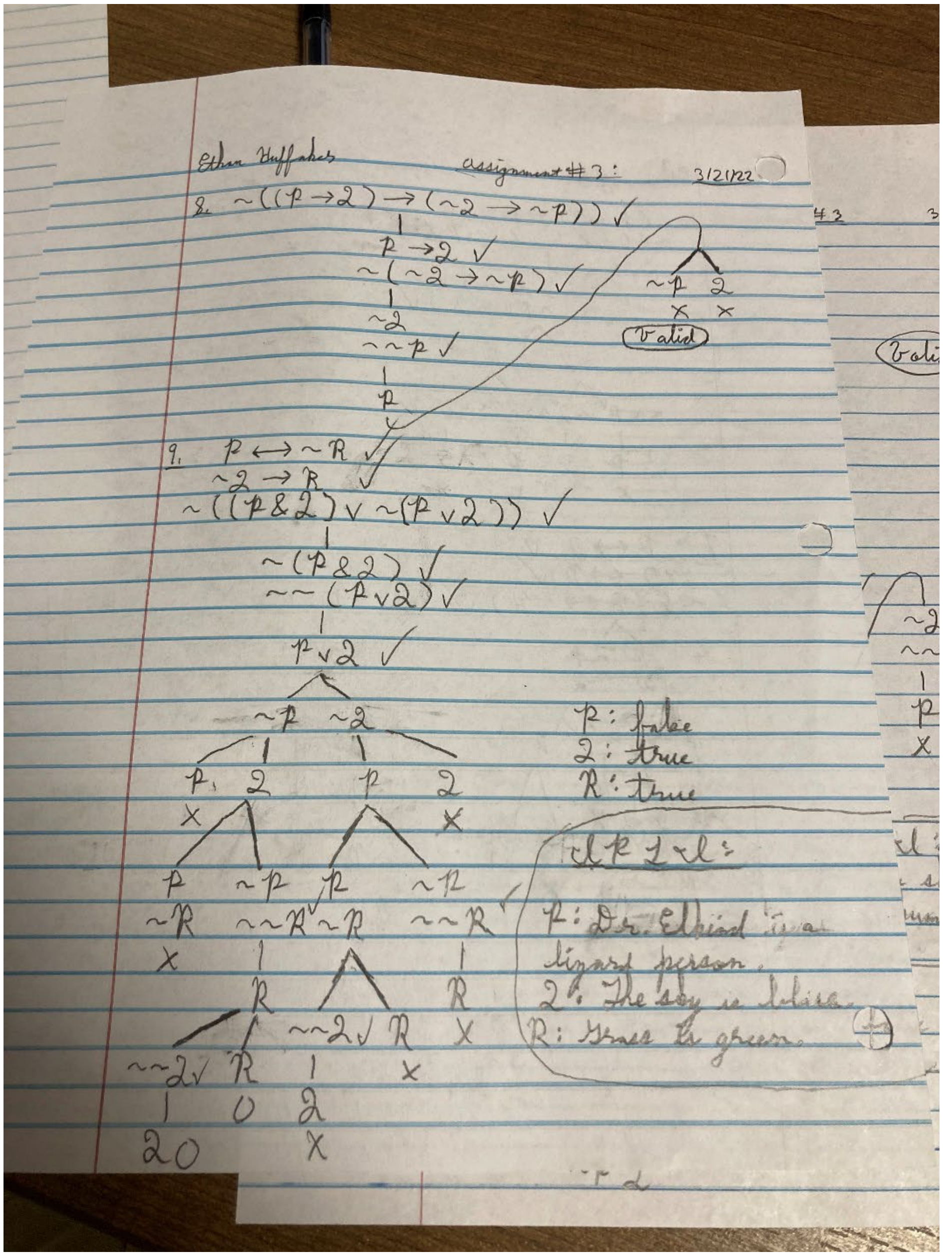
10. $\sim(\sim(p \,\&\, \sim q) \rightarrow (p \leftrightarrow q))$ ✓



p: false
q: true

[illegible]:

p: The sky is green on a sunny day.
q: Grass is green.



Ethan Huffaker   Assignment #3:   3/21/22

8. $\sim((P \to Q) \to (\sim Q \to \sim P))$ ✓

$P \to Q$ ✓

$\sim(\sim Q \to \sim P)$ ✓

$\sim Q$

$\sim\sim P$ ✓

P

$\sim P \quad Q$

X X

Valid

9. $P \leftrightarrow \sim R$ ✓

$\sim Q \to R$ ✓

$\sim((P \& Q) \vee \sim(P \vee Q))$ ✓

$\sim(P \& Q)$ ✓

$\sim\sim(P \vee Q)$ ✓

$P \vee Q$ ✓

$\sim P \quad \sim Q$

$P \quad Q \quad P \quad Q$

X X

$P \quad \sim P \quad R \quad \sim R$

$\sim R \quad \sim\sim R$ ✓ $\sim R \quad \sim\sim R$ ✓

X

$R \quad R$

$\sim\sim Q$ ✓ R X

$\sim\sim Q$ ✓ R X

$Q \quad O \quad Q$

$Q\,O$ X

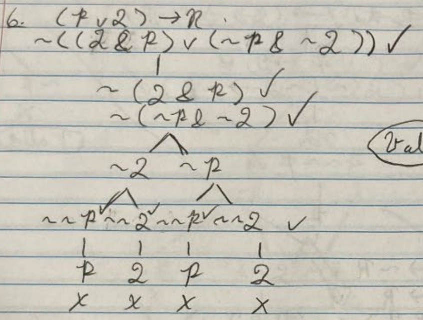
P: false
Q: true
R: true

Model:

P: Dr. Elkind is a lizard person.
Q: The sky is blue.
R: Grass is green.

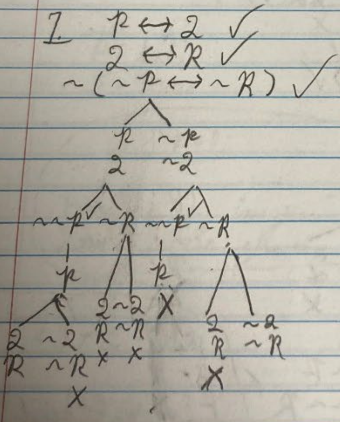
Ethan Huffaker Assignment #3 3/21/22

6.



(Valid)

7.



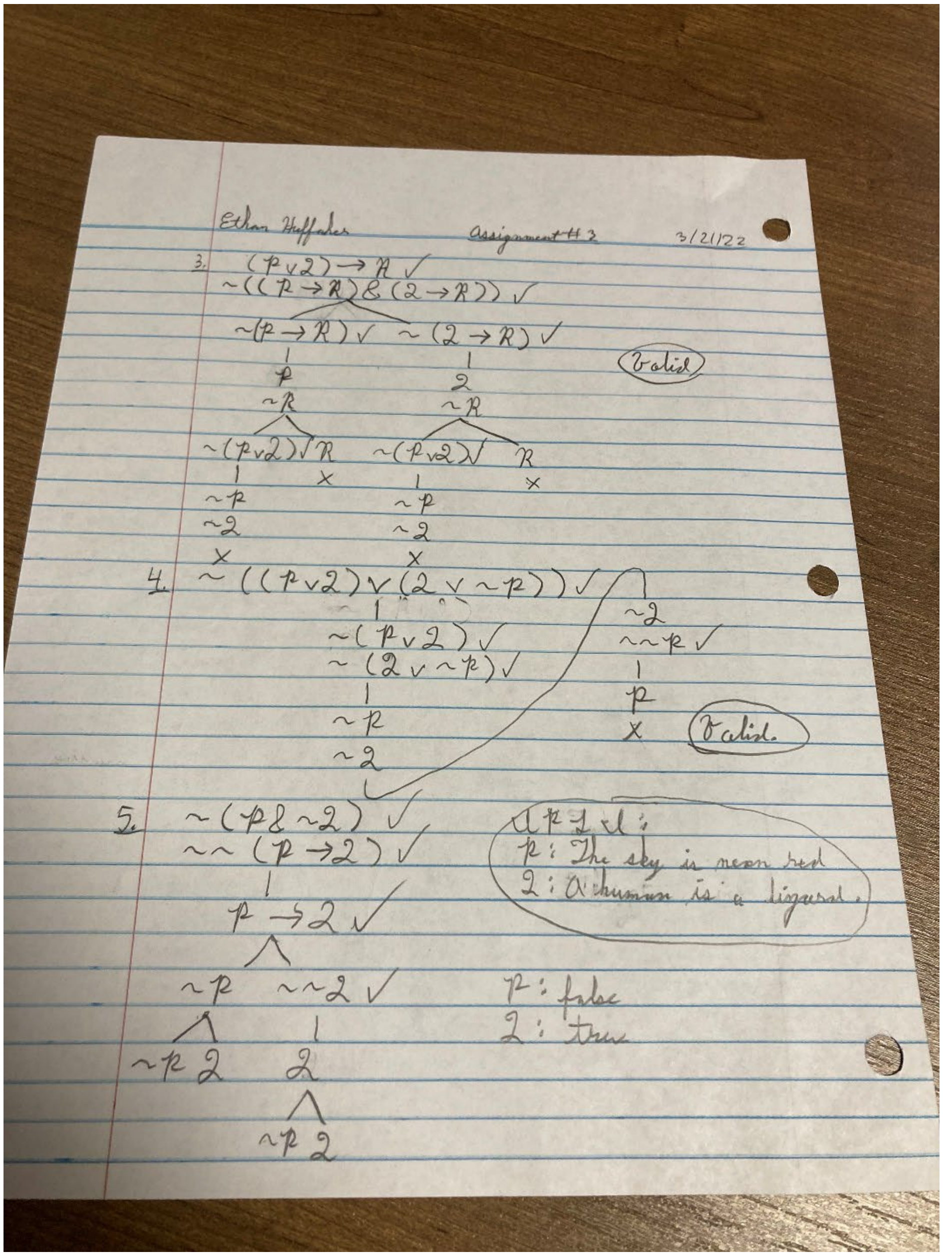
or

P : true
Q : true
R : true

P : false
Q : false
R : false

[illegible]:
P : The sky is blue
Q : Grass in Bowling Green is green.
R : Dr. Elkind is a human.

→



Ethan Huffaker   Assignment #3   3/21/22

3. $(P \vee Q) \rightarrow R$ ✓

$\sim((P \rightarrow R) \& (Q \rightarrow R))$ ✓

$\sim(P \rightarrow R)$ ✓ $\sim(Q \rightarrow R)$ ✓

P Q

$\sim R$ $\sim R$

$\sim(P \vee Q)$ ✓ R $\sim(P \vee Q)$ ✓ R

$\sim P$ × $\sim P$ ×

$\sim Q$ $\sim Q$

×   ×

Valid

4. $\sim((P \vee Q) \vee (Q \vee \sim P))$ ✓

$\sim(P \vee Q)$ ✓

$\sim(Q \vee \sim P)$ ✓

$\sim P$ $\sim Q$

$\sim Q$ $\sim\sim P$ ✓

P

×

Valid.

5. $\sim(P \& \sim Q)$ ✓

$\sim\sim(P \rightarrow Q)$ ✓

$P \rightarrow Q$ ✓

$\sim P$ $\sim\sim Q$ ✓

$\sim P$ Q Q

$\sim P$ Q

U P Q U:

P: The sky is neon red

Q: A human is a lizard.

P: false

Q: true

Ethan Huffaker Assignment #3 3/21/22

1.

$P \& P$ ✓

$\sim((Q \rightarrow Q) \leftrightarrow P)$ ✓

P

P

$Q \rightarrow Q \qquad \sim(Q \rightarrow Q)$ ✓

$\sim P \qquad P$

$\times \qquad Q$

$\sim Q$

$\times$

Valid

2. $\sim(\sim(Q \rightarrow R) \rightarrow \sim P) \rightarrow (\sim R \rightarrow \sim Q))$ ✓

$\sim(Q \rightarrow R) \rightarrow \sim P$

$\sim(\sim R \rightarrow \sim Q)$ ✓

$\sim R$

$\sim\sim Q$ ✓

Q

$\sim\sim(Q \rightarrow R)$ ✓ $\qquad \sim P$

$Q \rightarrow R$

$\sim Q \qquad R$

$\times \qquad \times$

UPQ&R:
P: The sky is green
Q: Joe Biden is the President of the United States.
R: Turtles are mammals

P: false
Q: true
R: false

Worked w/
Destiny &
Zoie B.

Assignment 3: Mary H.

1) $P \& P \nvdash (Q \to Q) \longleftrightarrow P$

$P \& P$

$(Q \to Q) \longleftrightarrow P$

P

P

$\sim P$

/ \

$\sim Q$ Q

X X

2) $\vdash (\sim(Q \to R) \to \sim P) \to (\sim R \to \sim Q))$

$\sim(Q \to R)$

$\sim P$

$(\sim R \to \sim Q)$

$\sim Q$ $\sim R$

/ \ / \

$\sim R$ $\sim Q$ $\sim Q$ $\sim R$

Q R R Q

/ \ / \

P $\sim P$ P $\sim P$

X X

3) $(P \vee Q) \to R \vdash (P \to R) \& (Q \to R)$

$(P \vee Q) \to R$

$(P \to R)$

$(Q \to R)$

$\sim R$

P

R

/ \

$\sim P$ Q

P = False
Q = true
P = Sky is Green
Q = grass is green
so, one implies
the other

Invalid

4) $\vdash (P \vee Q) \vee (Q \vee \sim P)$

$(P \vee Q)$

$(Q \vee \sim P)$

/ \

$(Q \vee \sim P)$ $(P \vee Q)$

$\sim P$

Q

/ \

$\sim P$ $\sim Q$

X

5) $\sim (P \& \sim Q) \vdash \sim (P \rightarrow Q)$

$\sim (P \& \sim Q)$

$\sim (P \rightarrow Q)$

$\sim P$

Q

/ \

$\sim P$ $\sim Q$

X

Q = false

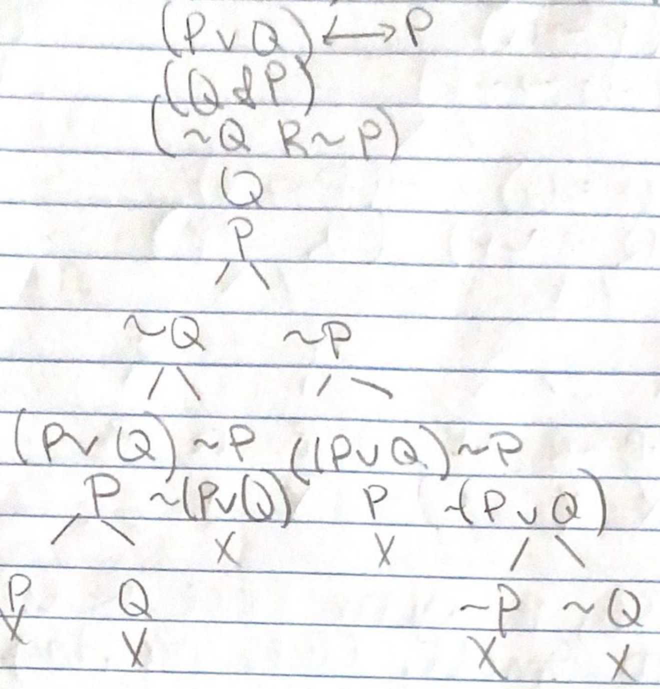
P = true

Q = red is green

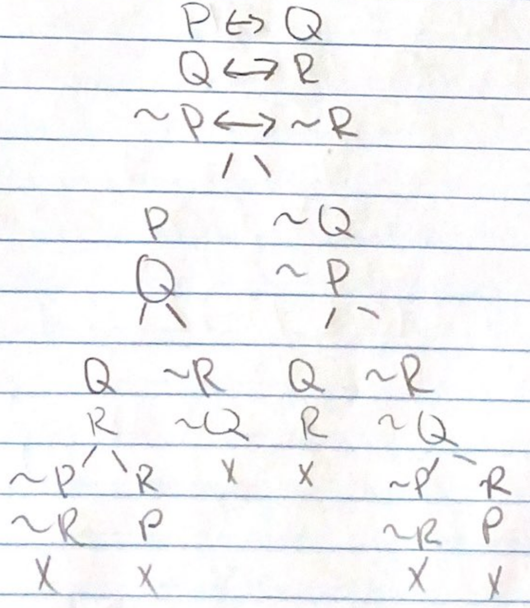
P = The sun is light

* If the sun is light, that implies that red is green

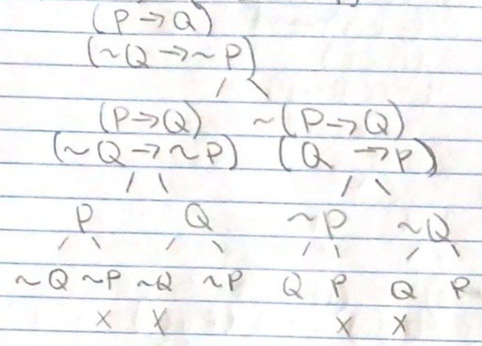
6) $(P \vee Q) \leftrightarrow P \vdash (Q \& P) \vee (\sim Q\ R \sim P)$



7) $P \leftrightarrow Q,\ Q \leftrightarrow R \vdash \sim P \leftrightarrow \sim R$



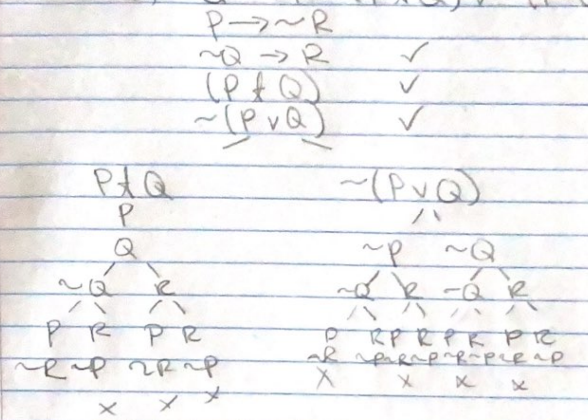
8) $\vdash (P \to Q) \to (\sim Q \to \sim P)$



* P = true
Q = false
P = your nose
is used
to smell
Q = cats
are dogs

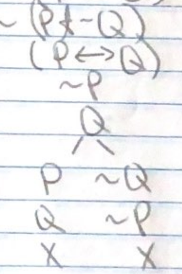
* So, if your nose is used
to smell, cats are dogs

9) $P \leftrightarrow \sim R,\ \sim Q \to R \therefore (P \& Q) \vee \sim (P \vee Q)$

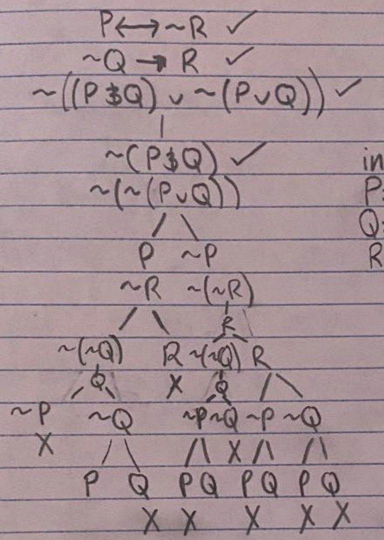


P = true = Dogs are mammals
Q = false = Cats are reptiles
R = false = Rats are reptiles
* So, if dogs are mammals,
Cats and rats are reptiles

10) $\sim(P \& \sim Q) \to (P \leftrightarrow Q)$

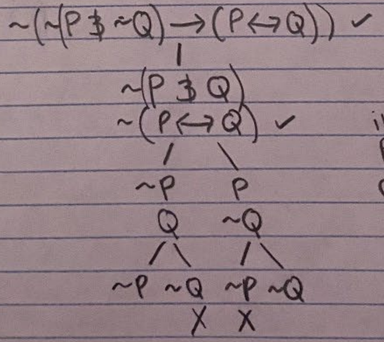


9)



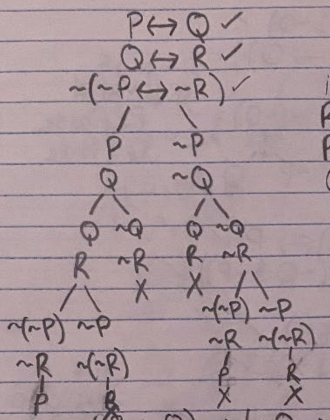
invald
P= False
Q=true
R=true

10)



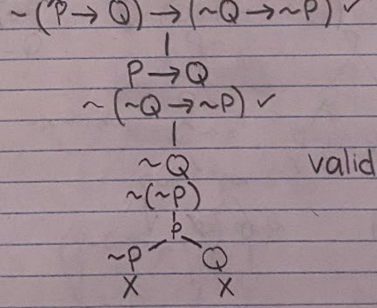
invalid
P=false
Q=true

7)



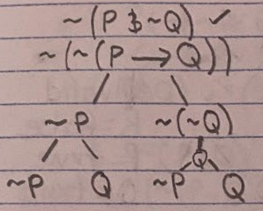
invalid
R=false
P=true
Q=true

8)



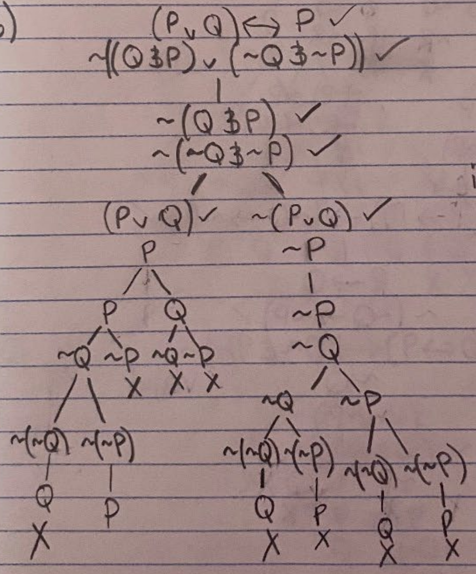
valid

5)



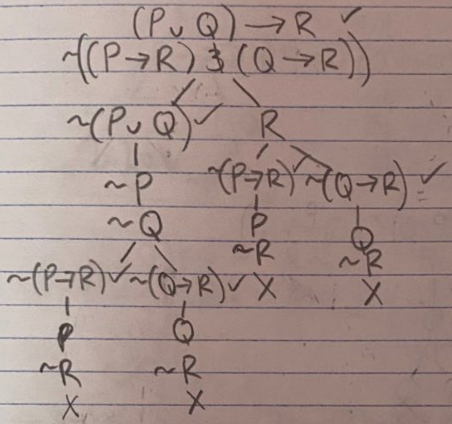
invalid
P=false
Q=true

6)



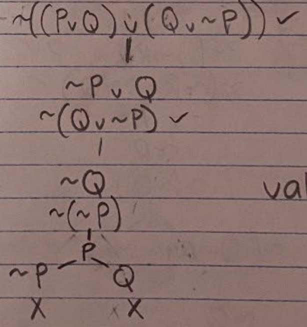
invalid
P=true
Q=false

3)



valid

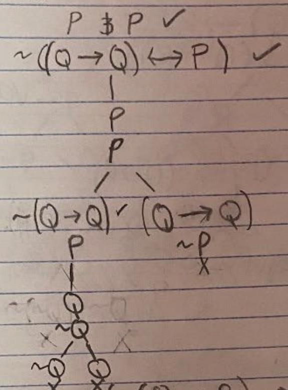
4)



valid

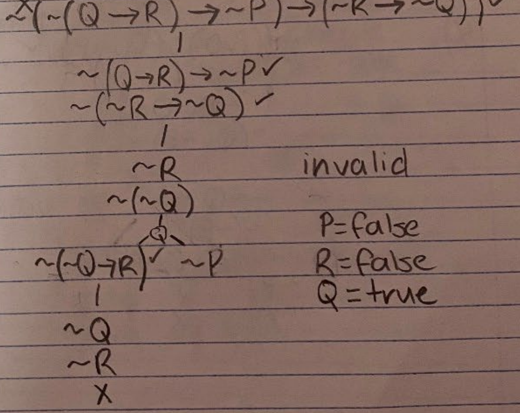
Assignment #3

1)



Valid

2)



invalid

P=false
R=false
Q=true

Symbolic Logic A. 3

1. $P \dot{\&} P \vdash \underbrace{(Q \to Q) \leftrightarrow P}_{\text{negate}}$

$P \dot{\&} P$

$\sim((Q \to Q) \leftrightarrow P)$

P

P

↙ ↘

$Q \to Q$ $\sim(Q \to Q)$

$\sim P$ P

✓ $\sim Q$

✓

argument is valid

2. $\vdash (\sim(Q \to R) \to \sim P) \to (\sim R \to \sim Q))$

↙ ↙ ↘

$(\sim(Q \to R) \to \sim P)$ $* \sim\sim R$ $\sim Q$

$\sim(Q \to R)$ $*$ R ✓

$* \sim\sim P$

Q

$\sim R$

$*$ P

argument is invalid

P / R = False

3. $(P \vee Q) \to R \vdash (P \to R) \dot{\&} (Q \to R)$

↙ ↘

$\sim(P \to R)$ $(P \to R) \dot{\&} (Q \to R)$

P $\sim(Q \to R)$

$\sim R$ $*$ ← ignore that Q

↙ ↘ ↓ $\sim R$

$\sim(P \vee Q)$ R $*$ ↙ ↘

$\sim P$ $\sim(P \vee Q)$ R

$\sim Q$ $\sim P$ ✓

✓ $\sim Q$

✓

argument is valid

4. $\vdash (P \vee Q) \vee (Q \vee \sim P)$

$\sim((P \vee Q) \vee (Q \vee \sim P)$

$\sim(P \vee Q)$

$\sim(Q \vee \sim P)$

$\sim Q$

$\sim\sim P$

✓

argument is valid

5. $\sim(P \overset{\cdot}{\underset{\cdot}{3}} \sim Q) \vdash \sim(P \rightarrow Q)$

$\sim(P \overset{\cdot}{\underset{\cdot}{3}} \sim Q)$

$\sim(P \rightarrow Q)$

↙	↘
* $\sim P$	$\sim Q$
* P	P
$\sim Q$	✓
✓	

argument is invalid P = false

6. $(P \vee Q) \leftrightarrow P \vdash (Q \overset{\cdot}{\underset{\cdot}{3}} P) \vee (\sim Q \overset{\cdot}{\underset{\cdot}{3}} \sim P)$

$(P \vee Q) \leftrightarrow P$

$(Q \overset{\cdot}{\underset{\cdot}{3}} P) \vee (\sim Q \overset{\cdot}{\underset{\cdot}{3}} \sim P)$

↙	↘
$P \vee Q$	$\sim(P \vee Q)$
P	$\sim P$

↙	↘	↙	↘
$Q \overset{\cdot}{\underset{\cdot}{3}} P$	* $\sim Q \overset{\cdot}{\underset{\cdot}{3}} \sim P$ *	$Q \overset{\cdot}{\underset{\cdot}{3}} P$	$\sim Q \overset{\cdot}{\underset{\cdot}{3}} \sim P$

↙	↘	↙	↘		
P	Q	* P	Q *	$\sim P$	$\sim P$
Q	P	$\sim Q$	$\sim P$	$\sim Q$	$\sim Q$
✓	✓				✓

argument is invalid P / Q = false

7. P

7. P ↔ Q, Q ↔ R ⊢ ~P ↔ ~R

(P ↔ Q)
(Q ↔ R)
~(~P ↔ ~R)
↙ ↘
~P   ~~P
~~R   *~R
R   P
↙ ↘   ↙ ↘
Q   ~Q   Q   ~Q
R   ~R   *R   ~R
✓   ✓   X   ✓

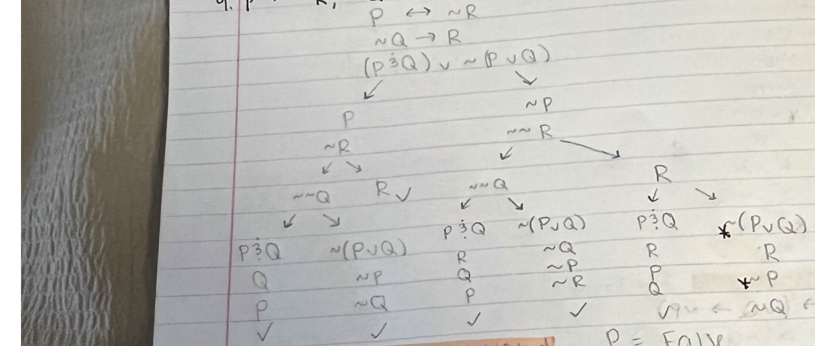
argument is invalid R = False

8. ⊢ (P → Q) → (~Q → ~P)

~((P → Q) → (~Q → ~P))
(P → Q)
~(~Q → ~P)
~Q
~~P
P
↙ ↘
~P   Q
✓   ✓

argument is valid

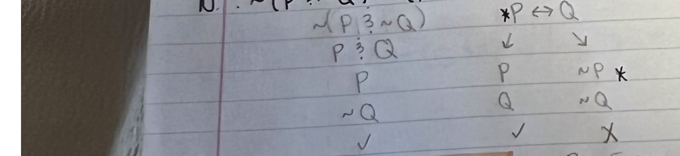
9. P ↔ ~R, ~Q → R : (P ⊻ Q) ∨ ~(P ∨ Q)



Argument is invalid

P = False

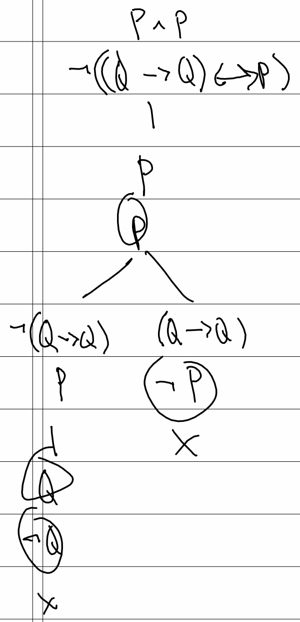
10. : ~(P ⊻ ~Q) → (P ↔ Q)



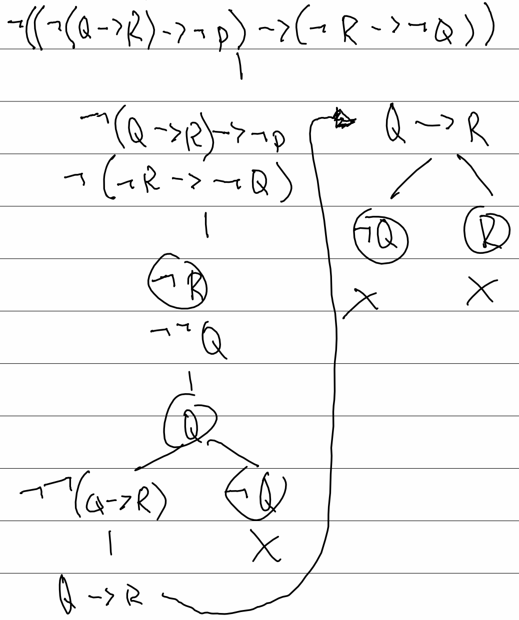
Argument is invalid

P = False

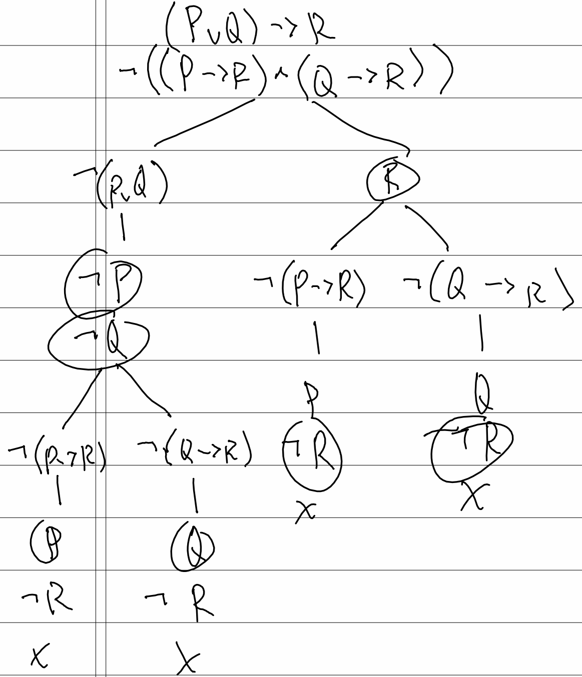
1. $P \wedge P \vdash (Q \rightarrow Q) \leftrightarrow P$ Valid ✓



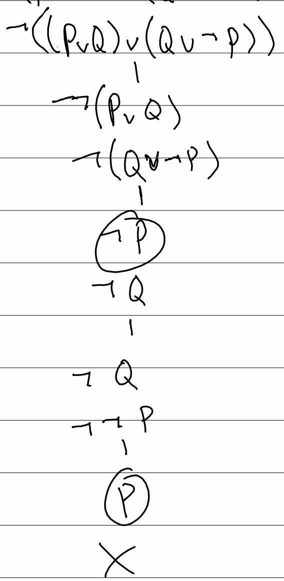
2. $\vdash (\neg(Q \rightarrow R) \rightarrow \neg P) \rightarrow (\neg R \rightarrow \neg Q)$ Valid ✓



3. $(P \lor Q) \to R \vdash (P \to R) \land (Q \to R)$ Valid ✓

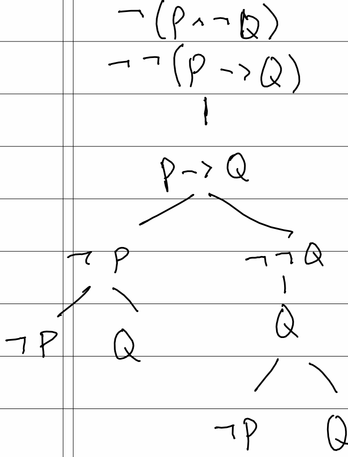


4. $\vdash (P \lor Q) \lor (Q \lor \neg P)$ Valid ✓



5. $\neg(P \wedge \neg Q) \vdash \neg(P \to Q)$ invalid

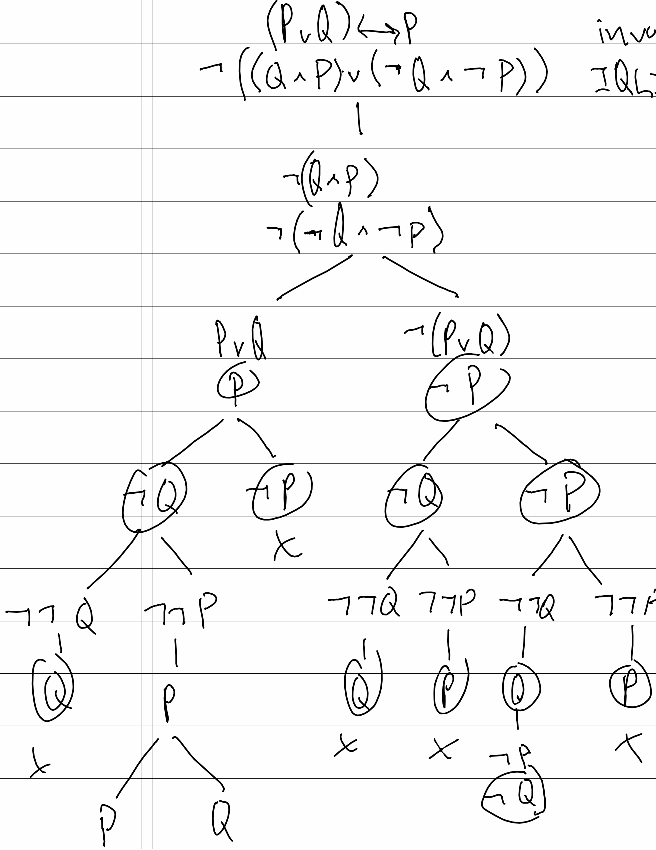
IQLI: p = false, Q = true



6. $(P \vee Q) \leftrightarrow P \vdash (Q \wedge P) \vee (\neg Q \wedge \neg P)$

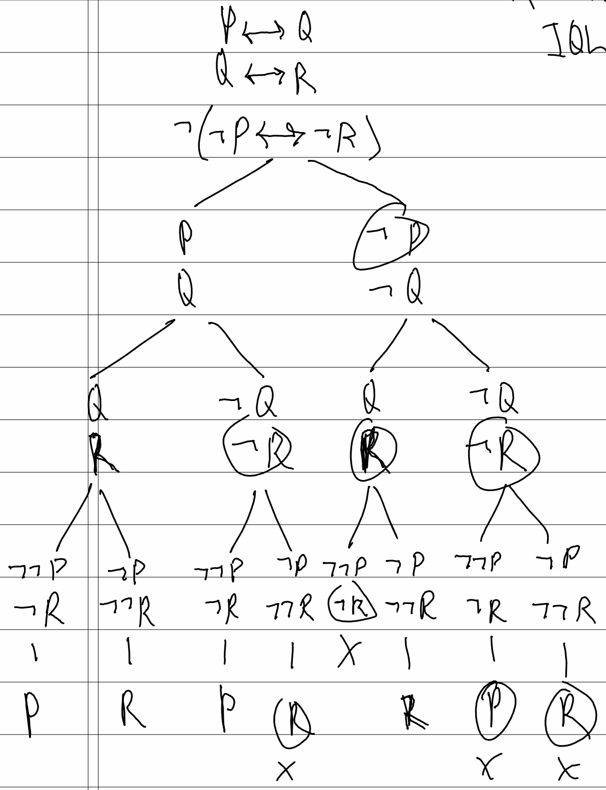
invalid

IQLI: P: true, Q: true/false



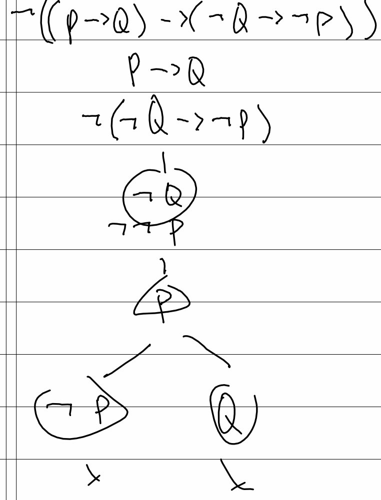
7. $P \leftrightarrow Q, Q \leftrightarrow R \vdash \neg P \leftrightarrow \neg R$ invalid

IQLI: P=true, R=true, Q=true/ false



8. $\vdash (P \rightarrow Q) \rightarrow (\neg Q \rightarrow \neg P)$

Valid ✓

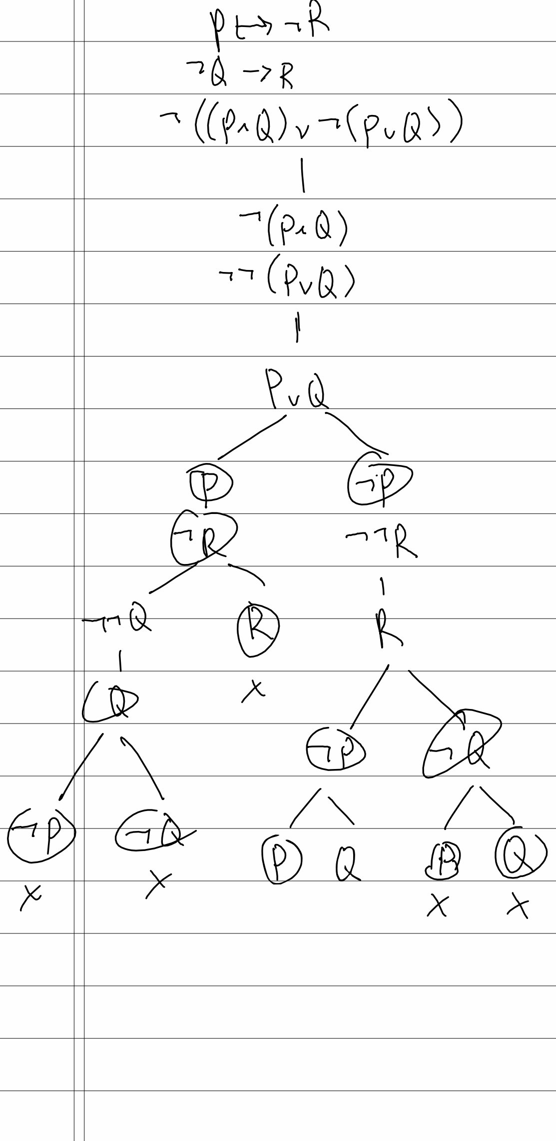


9. $P \leftrightarrow \neg R,\ \neg Q \to R \vdash (P \wedge Q) \vee \neg(P \vee Q)$ invalid

IQLI: Q = true

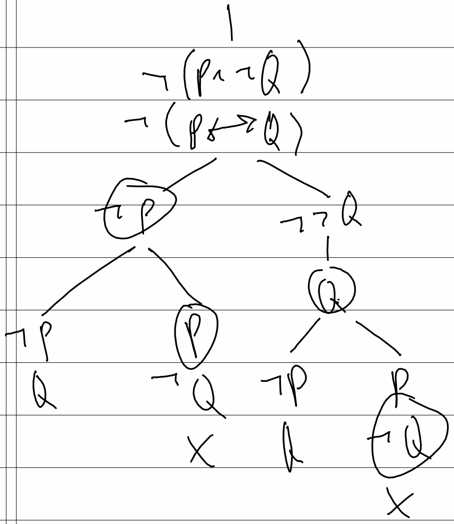
P = true/false

R = true



10. $\vdash \neg(P \wedge \neg Q) \rightarrow (P \leftrightarrow Q)$ invalid

$\neg(\neg(P \wedge \neg Q) \rightarrow (P \leftrightarrow Q))$ IQLI: P=false, Q=true



Assignment 6

① ~Fa : ~∀[Fx]

{1}	1.	~Fa	Premise
{2}	2.	∀x[Fx]	Assume RAA
{2}	3.	Fa	2UE
{1,2}	4.	Fa & ~Fa	1,3 &I
{1}	5.	~∀x[Fx]	2,4 RAA discharge RAA

② ∀x[∀y[Rxy]]: ∀y[∀x[Rxy]

{1}	1.	∀x[∀y[Rxy]]	Premise
{1}	2.	∀y[Rxy]	1UE
{1}	3.	[Rxy]	2UE
{1}	4.	∀x[Rxy]	3UI
{1}	5.	∀y[∀x[Rxy]]	4UI

[redacted]

③ Rab: ∃x[Rax] & ∃y[Ryb]

{1}	1.	Rab	Premise
{1}	2.	∃x[Rax]	1EI
{1}	3.	∃y[Ryb]	1EI
{1}	4.	∃x[Rax] & ∃y[Ryb]	2,3 &I

④ $\forall x[Fx \to (Gx \to Hx)], (Fa \& Ga) : \exists x[Hx]$

$\{1\}$ 1. $\forall x[Fx \to (Gx \to Hx)]$ Premise
$\{2\}$ 2. $(Fa \& Ga)$ Premise
$\{1\}$ 3. $[Fa \to Ga \to Ha)]$ 1 $\forall$E
$\{2\}$ 4. Fa 2&E
$\{2\}$ 5. Ga 2&E
$\{1,2\}$ 6. $(Ga \to Ha)$ 1,4 MP
$\{1,2\}$ 7. Ha 5,6 MP
$\{1,2\}$ 8. $\exists x[Hx]$ 7 $\exists$I

⑤ $\forall x[Fx \& Gx] : \forall y[Fy] \& \exists z[Gz]$

$\{1\}$ 1. $\forall x[Fx \& Gx]$ Premise
$\{1\}$ 2. $[Fy \& Gy]$ 1 $\forall$E
$\{1\}$ 3. Fy 2&E
$\{1\}$ 4. Gy 2&E
$\{1\}$ 5. $Fz \& Gz$ 1 $\forall$E
$\{1\}$ 6. Fz 5&E
$\{1\}$ 7. Gz 5&E
$\{1\}$ 8. $\forall y[Fy]$ 3 $\forall$I
$\{1\}$ 9. $\exists z[Gz]$ 7 $\exists$I
$\{1\}$ 10. $\forall y[Fy] \& \exists z[Gz]$ 8,9 &I

Meg Henderson

Credit : Trinity

Assignment 6 : PHIL215-005

① $\sim Fa : \sim\forall x[Fx]$

$\{1\}$ 1. $\sim Fa$ Premise

$\{2\}$ 2. $\sim\forall x[Fx]$ Assume for RAA

$\{2\}$ 3. Fa 2 UE

$\{1,2\}$ 4. $Fa \,\&\, \sim Fa$ 1,3 &I

$\{1\}$ 5. $\sim\forall x[Fx]$ 2,4 RAA discharge 2

② $\forall x[\forall y[Rxy]] : \forall y[\forall x[Rxy]]$

$\{1\}$ 1. $\forall x[\forall y[Rxy]]$ Premise

$\{1\}$ 2. $\forall y[Ray]$ 1 UE

$\{1\}$ 3. Rab 2 UE

$\{1\}$ 4. $\forall x[Rxb]$ 3 UI

$\{1\}$ 5. $\forall y[\forall x[Rxy]]$ 4 UE

③ $Rab \therefore \exists x[Rax] \& \exists y[Ryb]$

$\{1\}$	1.	Rab	Premise
$\{1\}$	2.	$\exists x[Rax]$	1 EI
$\{1\}$	3.	$\exists y[Ryb]$	1 EI
$\{1\}$	4.	$\exists x[Rax] \& \exists y[Ryb]$	2,3 &I

④ $\forall x[Fx \rightarrow (Gx \rightarrow Hx)], (Fa \& Ga) \therefore \exists x[Hx]$

$\{1\}$	1.	$\forall x[Fx \rightarrow (Gx \rightarrow Hx)]$	Premise
$\{2\}$	2.	$(Fa \& Ga)$	Premise
$\{1\}$	3.	$Fa \rightarrow (Ga \rightarrow Ha)$	1 UE
$\{2\}$	4.	Fa	2 &E
$\{2\}$	5.	Ga	4,3 MP
$\{1,2\}$	6.	$(Ga \rightarrow Ha)$	6,5 MP
$\{1,2\}$	7.	Ha	7 EI
$\{1,2\}$	8.	$\exists x[Hx]$	7 EI

Assignment 6 , PHIL 215-005

⑤ $\forall x[Fx \& Gax] : \forall y[Fy] \& \exists x[Gaz]$

{1}	1.	$\forall x[Fx \& Gax]$	Premise
{1}	2.	$Fa \& Gaa$	1 UE
{1}	3.	Fa	2 &E
{1}	4.	Gaa	2 &E
{1}	5.	$\forall y[Fy]$	3 UI
{1}	6.	$\exists z[Gaz]$	4 EI
{1}	7.	$\forall y[Fy] \& \exists x[Gaz]$	5,6 &I

Isabelle Hobbs

Symbolic Logic: Assignment 6

Prove the following arguments are valid.

1. ~Fa : ~∀x[Fx]

{1} 1. ~Fa	Premise
{2} 2. ∀x[Fx]	Assume for RAA
{2} 3. Fa	2 UE
{1,2} 4. Fa & ~Fa	1,3 &I
{1} 5. ~∀x[Fx]	2,4 RAA

2. ∀x[∀y[Rxy]] : ∀y[∀x[Rxy]]

{1} 1. ∀x[∀y[Rxy]]	Premise
{1} 2. ∀y[Ray]	1 UE
{1} 3. Rab	2 UE
{1} 4. ∀x[Rxb]	3 UI
{1} 5. ∀y[∀x[Rxy]]	4 UI

3. Rab : ∃x[Rax] & ∃y[Ryb]

{1} 1. Rab	Premise
{1} 2. ∃x[Rax]	1 EI
{1} 3. ∃y[Ryb]	1 EI
{1} 4. ∃x[Rax] & ∃y[Ryb]	2,3 &I

4. ∀x[Fx → (Gx → Hx)], (Fa & Ga) : ∃x[Hx]

{1} 1. ∀x[Fx → (Gx → Hx)]	Premise
{2} 2. Fa & Ga	Premise
{2} 3. Fa	2 &E
{1} 4. Fa → (Ga → Ha)	1 UE
{1,2} 5. Ga → Ha	3,4 CP
{2} 6. Ga	2 &E
{1,2} 7. Ha	5,6 CP
{1,2} 8. ∃x[Hx]	7 EI

5. ∀x[Fx & Gx] : ∀y[Fy] & ∃z[Gz]

{1} 1. ∀x[Fx & Gx]	Premise
{1} 2. Fa & Ga	1 UE
{1} 3. Fa	2 &E
{1} 4. ∀y[Fy]	3 UI
{1} 5. Ga	2 &E
{1} 6. ∃z[Gz]	5 EI
{1} 7. ∀y[Fy] & ∃z[Gz]	4,6 &I

Isabelle Hobbs

NO vE, will NOT need CP, will need RAA, NO assumptions at all #2, #3, #4, #5, may need other PL rules for #2-5

Symbolic Logic Assignment 6

1. ~Fa : ~∀x [Fx]
    - a. {1} 1. ~Fa Premise
    - b. {1} 2. ~∀x[Fx] 1 UI
2. ∀x[∀y[Rxy]] : ∀y[∀x[Rxy]]
    - a. {1} 1. ∀x[∀y[Rxy]] Premise
    - b. {1} 2. ∀y[Ray] 1 UE
    - c. {1} 3. Rab 2 UE
    - d. {1} 4. ∀x[Rxb] 3 UI
    - e. {1} 5. ∀y[∀x[Rxy]]
3. Rab : ∃x[Rax] & ∃y[Ryb]
    - a. {1} 1. Rab Premise
    - b. {1} 2. ∃x[Rax] 1 EI
    - c. {1} 3. ∃x[Rax] & Rab 2 &I
    - d. {1} 4. ∃x[Rax] & ∃y[Ryb] 3 EI
4. ∀x[F x → (Gx → Hx)], (F a & Ga) : ∃x[Hx]
    - a. {1} 1. ∀x[F x → (Gx → Hx)] Premise
    - b. {2} 2. (Fa & Ga) Premise
    - c. {1} 3. Fa -> (Ga -> Ha) 1 UE
    - d. {2} 4. Fa 2 &E
    - e. {2} 5. Ga 2 &E
    - f. {1,2} 6. Ga -> Ha 3, 4 MP
    - g. {1,2} 7. Ha 5,6 MP
    - h. {1,2} 8. ∃x[Hx] 7 EI
5. ∀x[F x & Gx] : ∀y[F y] & ∃z[Gz]
    - a. {1} 1. ∀x[F x & Gx] Premise
    - b. {1} 2. Fa & Ga 1 UE
    - c. {1} 3. Fa 2 &E
    - d. {1} 4. Ga 2 &E
    - e. {1} 5. ∀y[Fy] 3 UI
    - f. {1} 6. ∃z[Gz] 4 EI
    - g. {1} 7. ∀y[Fy] & ∃z[Gz] 5, 6 &I

Assignment #6: Ethan Huffaker

1. ~Fa: ~∀x[Fx]

{1} 1. ~Fa Premise
{2} 2. ~∀x[Fx] 1,UI

2. ∀x[∀y[Rxy]]: ∀y[∀x[Rxy]]

{1} 1. ∀x[∀y[Rxy]] Premise
{1} 2. ∀y[Ray] 1,UE
{1} 3. Rab 2,UE
{1} 4. ∀x[Rxb] 3,UI
{1} 5. ∀y[∀x[Rxy]] 4,UI

3. Rab: ∃x[Rax] & ∃y[Ryb]

{1} 1. Rab Premise
{1} 2. ∃x[Rax] 1,EI
{1} 3. ∃y[Ryb] 1,EI
{1} 4. ∃x[Rax] & ∃y[Ryb] 2,3,&I

4. ∀x[Fx → (Gx → Hx)], (Fa & Ga): ∃x[Hx]

{1} 1. ∀x[Fx → (Gx → Hx)] Premise
{2} 2. Fa & Ga Premise
{1} 3. Fa → (Ga → Ha) 1,UE
{2} 4. Fa 2,&E
{2} 5. Ga 2,&E
{1,2} 6. Ga → Ha 3,4,MP
{1,2} 7. Ha 5,6,MP
{1,2} 8. ∃x[Hx] 7,EI

5. ∀x[Fx & Gx]: ∀y[Fy] & ∃z[Gz]

{1} 1. ∀x[Fx & Gx] Premise
{1} 2. Fa & Ga 1,UE
{1} 3. Fa 2,&E
{1} 4. Ga 2,&E
{1} 5. ∀y[Fy] 3,UI
{1} 6. ∃z[Gz] 4,EI
{1} 7. ∀y[Fy] & ∃z[Gz] 5,6,&I

Ass. #6

Mary H.

① $\sim Fa : \sim \forall x[Fx]$

$\{1\}$ 1. $\sim Fa$

$\sim \forall x[Fx]$ UI

② $\forall x[\exists y[Rxy]] : \forall y(\forall x[Rxy]]$

$\{1\}$ 1. $\forall y[\forall y[Rxy]]$ premise

$\{1\}$ 2. $\forall y[\forall y[Rxy]]$ \VE

$\{1\}$ 3. $\forall y(\forall x[Rxy]])$ 2VE

③ $Rab : \exists x[Rax] \& \exists y(Ryb]$

$\{1\}$ 1. Rab

$\{1\}$ 2. $\exists x(Rax]$ 1EI

$\{1\}$ 3. $\exists y(Ryb]$ 1EI

4. $\exists x[Rax] \& \exists y(Ryb)$ 2,3&I

④ $\forall x(Fx \to (Gx \to Hx)], (Fa \& Ga) : \exists x(Hx]$

$\{1\}$ 1. $\forall x[Fx \to (Gx \to Hx)]$ Premise

$\{2\}$ 2. $Fa \& Ga$ Premise

$\{1\}$ 3. $Fa \to (Ga \to Ha)$ 1VI

$\{1,2\}$ 4. $Fa \to (Ga \to Ha) \& Fa \& Ga$ 2.3&I

$\{1,3\}$ 5. $(Ga \to Ha) \& Ga$ 4, IE for F

$\{1\}$ 6. Ha 5 IE for 6

$\{1\}$ 7. $\exists x[Hx]$ 6 EI

5) $\forall x[Fx \& Gx] : \forall y[Fy] \& \exists z[Gz]$

{1} 1. $\forall x[Fx \& Gx]$

{1} 2. $Fx \& Ga$ 1, $\forall$E

3. $FaGa$ 2& E

4 $\forall y[Fy]$ 3 $\forall$I

5 $\exists z(Gz)$ 3 EI

6. $\forall y[Fy] \& \exists z[Gz]$ 3,4,5 &I

Trent McGrath (Assisted by Justin Goins)

1)

~Fa : ~∀x[Fx]
{1} 1. ~Fa Premise
{2} 2. ~(~∀x[Fx]) Assume RAA df contradiction
{2] 3. ∀x[Fx] 2 DNE
{2} 4. Fa 3 UE
{1,2} 5. Fa & (~Fa) 1,4 &I
{1} 6. ~(~(~(∀x[Fx])) 2,5 RAA discharge 2
{1} 7. ~∀x[Fx] 6 DNE

2)

∀x[∀y[Rxy]] : ∀y[∀x[Rxy]]
{1} 1. ∀x[∀y[Rxy]] Premise
{1} 2. ∀y[Ray] 1 UE
{1} 3. Rab 2 UE
{1} 4. ∀x[Rxb] 3 UI
{1} 5. ∀y[∀x[Rxy] 4 UI

3)

Rab : ∃x[Rax] & ∃y[Ryb]

{1} 1. Rab Premise

{1} 2. ∃x[Rax] 1 EI

{1} 3. ∃x[Ryb] 1 EI

{1} 4. ∃y[Rax] & ∃y[Ryb] 1,3 &I

4)

∀x[Fx → (Gx → Hx)], (Fa & Ga), : ∃x[Hx]
{1} 1. ∀x[Fx → (Gx → Hx)] Premise
{2} 2. (Fa & Ga) Premise
{1}. 3. Fa → (Ga → Ha) 1 UE
{2} 4. Fa 2 &E
{2} 5. Ga 2 &E
{1,2} 6. Ga → Ha 3,4 MP

{1,2} 8. ∃x[Hx] 1 EI

5)

∀x[Fx → Gx] : ∀y[Fy] & ∃z[Gz]
{1} 1. ∀x[Fx → Gx] Premise
{1} 2. Fa & Ga 1 UE
{1} 3. Fa 2 &E
{1} 4. Ga 2 &E
{1} 5. ∀y[Fy] 3 UE
{1} 6. ∃z [Gz] 4 UE
{2} 7. ∀y[Fy] & ∃z [Gz] 5,6 &I

Seth Nevin (Assisted by Trent McGrath)
Phil 215
Doctor Elkind

1)

~Fa : ~∀x[Fx]
{1} 1. ~Fa Premise
{2} 2. ~(~∀x[Fx]) Assume RAA df contradiction
{2] 3. ∀x[Fx] 2 DNE
{2} 4. Fa 3 UE
{1,2} 5. Fa & (~Fa) 1,4 &I
{1} 6. ~(~(~(∀x[Fx])) 2,5 RAA discharge 2
{1} 7. ~∀x[Fx] 6 DNE

2)

∀x[∀y[Rxy]] : ∀y[∀x[Rxy]]
{1} 1. ∀x[∀y[Rxy]] Premise
{1} 2. ∀y[Ray] 1 UE
{1} 3. Rab 2 UE
{1} 4. ∀x[Rxb] 3 UI
{1} 5. ∀y[∀x[Rxy] 4 UI

3)

Rab : ∃x[Rax] & ∃y[Ryb]

{1} 1. Rab Premise

{1} 2. ∃x[Rax] 1 EI

{1} 3. ∃x[Ryb] 1 EI

{1} 4. ∃y[Rax] & ∃y[Ryb] 1,3 &I

4)

∀x[Fx → (Gx → Hx)], (Fa & Ga), : ∃x[Hx]

{1} 1. ∀x[Fx → (Gx → Hx)]	Premise
{2} 2. (Fa & Ga)	Premise
{1}. 3. Fa → (Ga → Ha)	1 UE
{2} 4. Fa	2 &E
{2} 5. Ga	2 &E
{1,2} 6. Ga → Ha	3,4 MP
{1,2} 8. ∃x[Hx]	1 EI

5)

∀x[Fx → Gx] : ∀y[Fy] & ∃z[Gz]

{1} 1. ∀x[Fx → Gx]	Premise
{1} 2. Fa & Ga	1 UE
{1} 3. Fa	2 &E
{1} 4. Ga	2 &E
{1} 5. ∀y[Fy]	3 UE
{1} 6. ∃z [Gz]	4 UE
{2} 7. ∀y[Fy] & ∃z [Gz]	5,6 &I

Symbolic logic A.6 Avery Pope

1. $\sim Fa : \sim\forall x[Fx]$

{1}	1.	$\sim Fa$	premise
{2}	2.	$\sim\forall x[Fx]$	Assume for RAA
{2}	3.	Fa	2 UE
{1,2}	4.	$Fa \,\&\, \sim Fa$	1, 3, & I
{1}	5.	$\sim\forall x[Fx]$	2, 4, RAA discharge 2

2. $\forall x[\forall y[Rxy]] : \forall y[\forall x[Rxy]]$

{1}	1.	$\forall x[\forall y[Rxy]]$	premise
{1}	2.	$\forall y[Rxy]$	1, UE
{1}	3.	Rab	2, UE
{1}	4.	$\forall x[Rxb]$	3, UE
{1}	5.	$\forall y[\forall x[Rxy]]$	4, UE

3. $Rab : \exists x[Rax] \,\&\, \exists y[Ryb]$

{1}	1.	Rab	premise

4. $\forall x[Fx \rightarrow (Gx \rightarrow Hx)], (Fa \,\&\, Ga) : \exists x[Hx]$

{1}	1.	$\forall x[Fx \rightarrow (Gx \rightarrow Hx)]$	premise
{2}	2.	$(Fa \,\&\, Ga)$	premise
{1}	3.	$\forall x[Fx]$	1, & E
{1}	4.	$(Gx \rightarrow Hx)$	1, & E
{2}	5.	Fa	2
{2}	6.	Ga	2

5. $\forall x[Fx \,\&\, Gx] : \forall y[Fy] \,\&\, \exists z[Gz]$

{1}	1.	$\forall x[Fx \,\&\, Gx]$	premise
{1}	2.	$[Fx \,\&\, Gx]$	1
{1}	3.	Fx	1, & E
{1}	4.	Gx	1, & E

1. $\neg Fa : \neg\forall x[Fx]$

$\{1\}$ 1. $\neg Fa$ Premise
$\{2\}$ 2. $\forall x[Fx]$ Assume for RAA
$\{2\}$ 3. Fa 2 UE
$\{1,2\}$ 4. $\neg Fa \wedge Fa$ 1,3 $\wedge$I
$\{1\}$ 5. $\neg\forall x[Fx]$ 2,4 RAA

2. $\forall x[\forall y[Rxy]] : \forall y[\forall x[Rxy]]$

$\{1\}$ 1. $\forall x[\forall y[Rxy]]$ Premise
$\{1\}$ 2. $\forall y[Ray]$ 1 UE
$\{1\}$ 3. Rab 2 UE
$\{1\}$ 4. $\forall x[Rxb]$ 3 UI
$\{1\}$ 5. $\forall y[\forall x[Rxy]]$ 4 UI

3. $Rab : \exists x[Rax] \wedge \exists y[Ryb]$

$\{1\}$ 1. Rab Premise
$\{1\}$ 2. $\exists x[Rax]$ 1 EI
$\{1\}$ 3. $\exists y[Ryb]$ 1 EI
$\{1\}$ 4. $\exists x[Rax] \wedge \exists y[Ryb]$ 2,3 $\wedge$I

4. $\forall x[Fx \to (Gx \to Hx)], (Fa \wedge Ga) : \exists x[Hx]$

$\{1\}$	1.	$\forall x[Fx \to (Gx \to Hx)]$	Premise
$\{2\}$	2.	$Fa \wedge Ga$	Premise
$\{1\}$	3.	$Fa \to (Ga \to Ha)$	1 UE
$\{2\}$	4.	Fa	2 $\wedge$E
$\{2\}$	5.	Ga	2 $\wedge$E
$\{1,2\}$	6.	$Ga \to Ha$	3,4 MP
$\{1,2\}$	7.	Ha	5,6 MP
$\{1,2\}$	8.	$\exists x[Hx]$	7 $\exists$I

5. $\forall x[Fx \wedge Gx] : \forall y[Fy] \wedge \exists z[Gz]$

$\{1\}$	1.	$\forall x[Fx \wedge Gx]$	Premise
$\{1\}$	2.	$Fa \wedge Ga$	1 UE
$\{1\}$	3.	Fa	2 $\wedge$E
$\{1\}$	4.	Ga	2 $\wedge$E
$\{1\}$	5.	$\forall y[Fy]$	3 UI
$\{1\}$	6.	$\exists z[Gz]$	4 $\exists$I
$\{1\}$	7.	$\forall y[Fy] \wedge \exists z[Gz]$	5,6 $\wedge$I