Study Guide and Notes for Chapter 1

Compiled by John Paul Cook

For use in conjunction with the course textbook:

Mathematics: A Practical Odyssey (Sixth Edition)
By David Johnson and Thomas Mowry

The exercises in this packet come from a variety of sources: the course textbook, and supplementary course materials provided by Ms. Christine Tinsley, University of Oklahoma; additionally, some of the exercises are original.
Section 1.1: Deductive versus Inductive Reasoning

Key Terms and Concepts
Deductive reasoning, inductive reasoning, valid argument, invalid argument, Venn Diagrams

Practice Problems

1) Classify each argument type as inductive or deductive:

   My television set did not work two nights ago.
   My television set did not work last night.
   Therefore, my television set is broken.

   All electronic devices give their owners grief.
   My television set is an electronic device.
   Therefore, my television set gives me grief.

2) Construct a Venn Diagram to determine the validity of the given argument

   All roads lead to Rome.
   Route 66 is a road.
   Therefore, Route 66 leads to Rome.

   All pesticides are harmful to the environment.
   No fertilizer is a pesticide.
   Therefore, no fertilizer is harmful to the environment.
No professor is a millionaire.
No millionaire is illiterate.
Therefore, no professor is illiterate.

Some women are police officers.
Some police officers ride motorcycles.
Therefore, some women ride motorcycles.

**Writing and Understanding**

3) Explain the difference between deductive and inductive reasoning.

4) Explain why validity does not imply truth. In other words, why does saying that an argument is valid not necessarily imply that the conclusion is true?

**Section 1.1 Homework: 1, 4, 7, 8, 10, 15, 18, 19, 22**
Section 1.2: Symbolic Logic

Key Terms and Concepts

Statement, compound statement, the word “some”, negation, conjunction, disjunction, conditional, inclusive or

Practice Problems

1) Determine which of the following sentences are statements. Explain.

a. Apple manufactures computers.

b. Apple manufactures the world’s best computers.

c. Did you buy an IBM?

d. A $2000 computer purchased at a 25% discount will cost $1000.

2) Draw the “negation chart”, and use it to negate the statements below:

a. She is not a vegetarian.

b. Some elephants are pink.

c. All candy promotes tooth decay.

d. No lunch is free.
3) Write the following conditionals in “if . . . then” form:

   a. All mammals are warm-blooded.

   b. No snake is warm blooded.

4) Write the following conditionals \( p \rightarrow q \) in the form \( q \) if \( p \):

   a. If I exercise regularly, then I am healthy.

   b. If I eat junk food and do no exercise, then I am not healthy.

5) Using the symbolic representations:

   \( p \): The lyrics are controversial.
   \( q \): The performance is banned.

   express the following compound statements in symbolic form.

   a. The lyrics are controversial and the performance is banned.

   b. If the lyrics are not controversial, the performance is not banned.

   c. It is not the case that the lyrics are controversial or the performance is banned.

   d. The lyrics are controversial and the performance is not banned.
6) Using the symbolic representations:

\[ p: \text{The car costs $40,000.} \]
\[ q: \text{The car goes 140mph.} \]
\[ r: \text{The car is red.} \]

express the following compound statements in symbolic form.

a. All red cars go 140mph.

\[ r \land q \]

b. The car is red, goes 140mph, and does not cost $40,000.

\[ r \land q \land \neg p \]

c. If the car does not cost $40,000, it does not go 140mph.

\[ \neg p \rightarrow \neg q \]

d. The car is red and it does not go 140mph or cost $40,000.

\[ r \land (\neg q \lor \neg p) \]

7) Translate the sentence into symbolic form. Be sure to define each letter you use.

a. All squares are rectangles.

\[ s \rightarrow r \]

b. I do not sleep soundly if I drink coffee or eat chocolate.

\[ (c \lor e) \rightarrow \neg s \]

c. If you drink and drive, you are fined or you go to jail.

\[ (d \land e) \rightarrow (f \lor g) \]
8) Using the symbolic representations:

\[ p: \text{The car costs } \$40,000. \]
\[ q: \text{The car goes } 140\text{mph.} \]

express the following in words:

a. \( p \land q \)

b. \( p \rightarrow q \)

c. \( \neg q \rightarrow \neg p \)

d. \( q \lor \neg p \)

9) Using the symbolic representations:

\[ p: \text{I am an environmentalist.} \]
\[ q: \text{I recycle my aluminum cans.} \]
\[ r: \text{I recycle my newspapers.} \]

express the following in words:

a. \( (q \lor r) \rightarrow p \)

b. \( \neg p \rightarrow \neg (q \lor r) \)

c. \( (q \land r) \lor \neg p \)

d. \( (r \land \neg q) \rightarrow \neg p \)
Writing and Understanding

10) Explain why the negation of the statement “Some $p$ are $q$” is not “Some $p$ are not $q$”.

11) Explain why the negation of the statement “All $p$ are $q$” is not “No $p$ are $q$”.

12) Why is it helpful when breaking statements down to define the statements without negations? For instance, we will often do this:

We can write “This car is not fast” as $\sim p$, where we let $p$ be the statement “This car is fast.”

Why would we not just let the original statement be $p$?

Section 1.2 Homework: 1, 4, 8, 9, 12, 15, 18, 20, 21, 28, 30
Section 1.3: Truth Tables

Key Terms and Concepts

truth table, conjunction, disjunction, conditional, equivalent expressions, DeMorgan’s Laws

Practice Problems

1) Write the truth table for each of the following compound statements

   a. Negation: ~p

   b. Conjunction: p ∧ q

   c. Disjunction: p ∨ q

   d. Conditional: p → q
2) Complete the following truth table:

<table>
<thead>
<tr>
<th>$p$</th>
<th>$q$</th>
<th>$\sim p$</th>
<th>$q \land \sim p$</th>
<th>$p \lor (q \land \sim p)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>F</td>
<td>T</td>
<td>F</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
</tbody>
</table>

3) How many rows are required in a truth table?

4) Complete the following truth table for the symbolic expression $(q \land p) \rightarrow (\sim r \lor p)$:

<table>
<thead>
<tr>
<th>$p$</th>
<th>$q$</th>
<th>$r$</th>
<th>$q \land p$</th>
<th>$\sim r$</th>
<th>$\sim r \lor p$</th>
<th>$(q \land p) \rightarrow (\sim r \lor p)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>T</td>
<td>T</td>
<td>T</td>
<td></td>
<td></td>
<td>T</td>
</tr>
<tr>
<td>T</td>
<td>T</td>
<td>F</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>T</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>T</td>
<td>T</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>T</td>
<td>F</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5) Construct a truth table for the following expressions to determine when each statement is true or false:

a. No square is a triangle.
b. Your check is accepted if you have a driver’s license or a credit card.

6) Determine if the given statements are equivalent using truth tables:

If the spotted owl is on the endangered species list, then lumber jobs are lost.

If lumber jobs are not lost, then the spotted owl is not on the endangered species list.

7) Using truth tables, show that the expression $\sim p \lor q$ is equivalent to the conditional $p \rightarrow q$.
8) State DeMorgan’s Laws

9) Using truth tables, verify the given part of DeMorgan’s Laws (the other is for homework): \( \sim (p \land q) \equiv p \lor \sim q \)

10) Using DeMorgan’s Laws, negate the following symbolic expressions:
    a. \( p \rightarrow q \) (for this part, use the result from question 7)
    b. \( p \land \sim (q \lor r) \)

11) Write the statement in symbolic form, and then use DeMorgan’s laws to find the negation. Then rewrite the negated statement in words.
    a. I have a college degree and I am not employed.
    b. If the legislation is approved, the public is uninformed.
Writing and Understanding

1) Explain why truth tables are used and studied.

2) Explain why the only time the truth values of a conditional are false is if the hypothesis is true and the conclusion is false (i.e. if \( p \) is true and \( q \) is false).

3) Since there is no set number for the columns in the truth table (unlike the rows), explain a useful method for how to label the columns of a truth table.

4) Can you think of a way to write “Some \( p \) are \( q \)” symbolically (so that statements of this form may be used in truth tables)? Hint: it’s a kind of compound statement that we have already learned about. Think about a specific example to help.

Section 1.3 Homework: 2, 5, 8, 11, 16, 20, 22, 29, 32, 33, 38, 44, 48, 51, 56
Section 1.4: More on Conditionals

Key Terms and Concepts

Conditional, converse, inverse, contrapositive, biconditional,

Practice Problems

1) Give the following, in both symbols and words, for the following statements:
   \( p: \) She is a police officer.
   \( q: \) She carries a gun.

   a. Conditional \( (p \rightarrow q) \)

   b. Converse \( (\quad \rightarrow \quad) \)

   c. Inverse \( (\quad \rightarrow \quad) \)

   d. Contrapositive \( (\quad \rightarrow \quad) \)

2) Make a truth table for the conditional and its three variations listed above:

3) Which variations of the conditional are equivalent, based on the truth table from problem 2? Write these equivalencies in both symbols and words.
4) Which out of the following are equivalent? Explain.
   \[ p \rightarrow \neg q , \ \neg q \rightarrow p , \ \neg p \rightarrow q , \ q \rightarrow p \]

5) Translate the two sentences into symbolic form, and use truth tables to determine whether
   the statements are equivalent:
   
   I cannot have surgery if I do not have health insurance.
   If I can have surgery, then I do have health insurance.

6) Write equivalent variations of the given conditionals:
   a. If it is not raining, I will walk to work.

   b. You are a criminal only if you do not obey the law.

7) Determine which of the following pairs of statements are equivalent:
   a. If the Giants win, then I am happy.
      If I am happy, then the Giants win.
      If the Giants lose, then I am unhappy.
      If I am unhappy, then the Giants lose.
b. I am a rebel if I do not have a cause.
   I am a rebel only if I do not have a cause.
   I am not a rebel if I have a cause.
   If I am not a rebel, I have a cause.

8) Write the following in “if …. then …. form:
   a. $p$ only if $q$

   b. I eat raw fish only if I am in a Japanese restaurant.

9) The following problems involve the biconditional $p \iff q$, i.e. $p$ if and only if $q$, $p$ iff $q$
   a. The symbol $p \iff q$ is given by: $p \iff q = \______________$
   b. Write the biconditional for the statements $p$ and $q$ in problem 1:
   c. Construct the truth table for the biconditional:
   d. When is a biconditional statement true?

10) Express the given biconditional as a conjunction of two conditionals (use problem 9a):
    A triangle is equilateral if and only if it has three equal sides
Writing and Understanding

11) Why is it helpful to know equivalencies of symbolic expressions?

12) Give two examples of a biconditional statement. Explain why you are able to write them in this manner.

Section 1.4 Homework: 2, 3, 6, 9, 12ab, 15ab, 17, 22, 25, 28, 30, 33, 37
Section 1.5: Analyzing Arguments

Key Terms and Concepts

Argument, valid argument, tautology

Practice Problems

1) Write down the symbolic representation of an argument with hypotheses $h_1,...,h_n$ and conclusion $c$:

2) Recall from section 1 that a valid argument is an argument in which the conclusion is unavoidable. How can we reformulate this definition in terms of truth tables?

3) Write down the steps for using truth tables to determine if an argument is valid:

4) Determine if the following argument is valid or invalid:

\[
\begin{align*}
\sim p \rightarrow q \\
p \lor r \\
\therefore \sim p \lor r
\end{align*}
\]
5) Using truth tables, determine whether the following argument is valid:

If he is illiterate, he cannot fill out the application.
He can fill out the application.
Therefore, he is not illiterate.

6) Using truth tables, determine whether the following argument is valid:

If the defendant is innocent, the defendant does not go to jail.
The defendant does not go to jail.
Therefore, the defendant is innocent.
7) Using truth tables, determine whether the following argument is valid:

No professor is a millionaire.
No millionaire is illiterate.
Therefore, no professor is illiterate.
Writing and Understanding

8) Explain how the two definitions we have for valid argument are equivalent.

Section 1.5 Homework: 10, 11, 14, 15, 18, 19, 22
Chapter 1 Review

The next few pages contain review materials to help you review for the Chapter 1 Exam. Please note that the practice exams provide only a means to review for the exam – the actual exam will not be written directly from the practice exams.

Additionally, a review assignment from the Chapter 1 Review in the textbook (pg. 58) has been listed below, and may be assigned as homework.

The sources of review that you have for the exam include:

** assigned homework / quizzes

** notes / problems worked in class (i.e. from this packet)

** practice exams

Chapter 1 Review Homework: 1, 5, 9, 11, 13, 15, 17, 21, 25, 29, 33, 36, 37, 40, 41, 44, 45, 47
Part I: Definitions and basic results [1 pt each]

Problem 1: Define the following terms:

a. negation:

b. disjunction:

c. conjunction:

d. conditional:

e. statement:

f. valid argument:

g. tautology:

Problem 2: Write the symbolic forms of the following variations of the conditional $p \rightarrow q$:

a. biconditional

b. contrapositive

c. inverse

d. converse

Problem 3: State DeMorgan’s Laws:

a.

b.

Problem 4: Rewrite the following conditionals in an alternative symbolic form:

a. $p$ if $q$

b. $p$ only if $q$
The following questions are multiple choice. Circle the correct answer. Each one is worth 4 points.

1. Which of the following sentences is a statement?
   a. Did you wash your hands?
   b. Tree trunks are brown.
   c. OU is an excellent school.
   d. Wash your car.
   e. Study hard for this exam.

2. Use a Venn diagram to determine if the following argument is valid or invalid.

   1. All money is green.
   2. All leaves are green.

   Therefore, all leaves are money.

   a. Valid
   b. Invalid
3. What is the negation of the following statement?  
   "Some tigers are not white."
   
a. Some tigers are white.
   
b. No tigers are white.
   
c. All tigers are white.
   
d. All tigers are not white.
   
e. None of the above.

4. Given the following argument:
   
   1. \( \sim p \rightarrow q \)
   2. \( p \lor r \)
   
   \( \therefore \sim p \land r \)
   
   Is the above argument valid or invalid?
   
a. Valid
   
b. Invalid

5. What is the hypothesis of the following statement?  
   "I go to the grocery store only if I do not have bread or I do not have milk."
   
a. I do not have bread.
   
b. I do not have milk.
   
c. I do not have milk or I do not have bread.
   
d. I go to the grocery store.
   
e. None of the above.
6. What is the negation of the following statement? “I have weird dreams, if I take sleeping pills.”
   a. If I don’t take sleeping pills then I do not have weird dreams.
   b. If I do not have weird dreams then I take sleeping pills.
   c. I take sleeping pills and I do not have weird dreams.
   d. I do not take sleeping pills and I have weird dreams.
   e. None of the above.

7. Construct a truth table for \((p \land \sim q) \leftrightarrow \sim r\). How many entries in the final column of the truth table are false?
   a. 8
   b. 7
   c. 6
   d. 5
   e. None of the above.

8. What is the converse of the following statement? “All athletes eat meat.”
   a. If you eat meat then you are an athlete.
   b. If you are not an athlete then you do not eat meat.
   c. If you are an athlete then you eat meat.
   d. If you do not eat meat then you are not an athlete.
   e. None of the above.
9. What is the negation of \( \sim p \land q \)?
   
   a. \( \sim p \land \sim q \)
   b. \( p \land \sim q \)
   c. \( p \lor \sim q \)
   d. \( p \rightarrow q \)
   e. None of the above.

10. Which statement is the contrapositive of the following statement?
    "If I am late for class then I did not wash my face and I did not eat breakfast."
    
    a. If I wash my face or eat breakfast then I am not late for class.
    b. If I am not late for class then I washed my face or I ate breakfast.
    c. If I do not wash my face and I don’t eat breakfast then I am late for class.
    d. I am late for class, I washed my face and I ate breakfast.
    e. None of the above.

11. What is the inverse of the following statement?
    "I receive an A if I complete my homework."
    
    a. If I receive an A then I complete my homework.
    b. If I do not complete my homework then I will not receive an A.
    c. If I do not receive and A then I did not complete my homework.
    d. If I do not complete my homework then I receive an A.
    e. None of the above.
12. What is the negation of the following statement?
   "We have an exam on Friday and it does not cover chapter one."
   
a. We do not have an exam on Friday and it covers chapter one.
   
b. We have an exam on Friday or it does not cover chapter one.
   
c. If we have an exam on Friday then it does not cover chapter one.
   
d. We do not have an exam on Friday or it covers chapter one.
   
e. None of the above.

13. What type of reasoning goes from specific to general?
   
a. syllogism
   
b. tautology
   
c. deductive
   
d. inductive
   
e. None of the above.

14. Which of the following is equivalent to \( \sim q \land p \)?
   
a. \( p \rightarrow q \)
   
b. \( \sim(p \rightarrow q) \)
   
c. \( \sim p \lor q \)
   
d. \( \sim q \rightarrow p \)
   
e. None of the above.
15. Is the following a tautology?

\[(p \land q) \rightarrow (p \lor q)\]

a. tautology

b. not a tautology
Make sure to show all of your work when needed on the following problems. Each one is worth the indicated amount of points.

1. Given the following argument:

   1. If you wear polka dots, you do not wear stripes.
   2. You wear solid colors only if you wear stripes.

   Therefore, you do not wear solid colors if you wear polka dots.

   \[ p: \text{You wear polka dots.} \]
   \[ q: \text{You wear solid colors.} \]
   \[ r: \text{You wear stripes} \]

   a. Write each part of the argument in symbolic form. (6 points)

   b. Combine the argument together. (5 points)

   c. Construct a truth table to determine if the argument is valid or invalid. (9 points)
2. Use a Venn diagram to determine if the following argument is valid or invalid. (7 points)

1. No politician lies.
2. Some lawyers lie.

Therefore, no politicians are lawyers.

3. Given the following statement:
   "You attend OU only if you have excellent ACT scores and did not have bad grades in high school."

   p: You attend OU.
   q: You have excellent ACT scores.
   r: You had bad grades in high school.

   a. Write the statement in symbolic form. (5 points)

   b. Construct a truth table for the statement. (8 points)
The following questions are multiple choice. Circle the correct answer. Each one is worth 4 points.

1. Which of the following sentences is a statement?
   a. Did you wash your hands?  question
   b. Tree trunks are brown.
   c. OU is an excellent school.  opinion
   d. Wash your car.  command
   e. Study hard for this exam.  command

2. Use a Venn diagram to determine if the following argument is valid or invalid.
   1. All money is green.
   2. All leaves are green.
   Therefore, all leaves are money.
   a. Valid
   b. Invalid
3. What is the negation of the following statement? 
   "Some tigers are not white."
   a. Some tigers are white.
   b. No tigers are white.
   c. All tigers are white.
   d. All tigers are not white.
   e. None of the above.

4. Given the following argument:
   1. \( \sim p \rightarrow q \)
   2. \( p \lor r \)
   \[ \therefore \sim p \land r \]
   Is the above argument valid or invalid?
   a. Valid
   b. Invalid

5. What is the hypothesis of the following statement? 
   "I go to the grocery store only if I do not have bread or I do not have milk."
   a. I do not have bread.
   b. I do not have milk.
   c. I do not have milk or I do not have bread.
   d. I go to the grocery store.
   e. None of the above.
6. What is the negation of the following statement?
   "I have weird dreams, if I take sleeping pills."

   a. If I don't take sleeping pills then I do not have weird dreams.
   b. If I do not have weird dreams then I take sleeping pills.
   c. I take sleeping pills and I do not have weird dreams.
   d. I do not take sleeping pills and I have weird dreams.
   e. None of the above.

   \[ p \rightarrow q \quad \sim(p \rightarrow q) \equiv p \land \sim q \]

7. Construct a truth table for \((p \land \sim q) \leftrightarrow \sim r\). How many entries in the final column of the truth table are false?

   a. 8
   b. 7
   c. 6
   d. 5
   e. None of the above.

8. What is the converse of the following statement?
   "All athletes eat meat."

   a. If you eat meat then you are an athlete.
   b. If you are not an athlete then you do not eat meat.
   c. If you are an athlete then you eat meat.
   d. If you do not eat meat then you are not an athlete.
   e. None of the above.

   \[ p \rightarrow q \quad \text{converse} \quad q \rightarrow p \]
9. What is the negation of \( \sim p \land q \)?
   a. \( \sim p \land \sim q \)
   b. \( p \land \sim q \)
   c. \( p \lor \sim q \)
   d. \( p \rightarrow q \)
   e. None of the above.

\[ \sim (p \land q) \equiv \sim (p) \lor \sim q \equiv p \lor \sim q \]

10. Which statement is the contrapositive of the following statement?
    "If I am late for class then I did not wash my face and I did not eat breakfast."
   a. If I wash my face or eat breakfast then I am not late for class.
   b. If I am not late for class then I washed my face or I ate breakfast.
   c. If I do not wash my face and I don’t eat breakfast then I am late for class.
   d. I am late for class, I washed my face and I ate breakfast.
   e. None of the above.

\[ \sim (p \lor q) \equiv \sim p \land \sim q \]

11. What is the inverse of the following statement?
    "I receive an A if I complete my homework."
   a. If I receive an A then I complete my homework.
   b. If I do not complete my homework then I will not receive an A.
   c. If I do not receive and A then I did not complete my homework.
   d. If I do not complete my homework then I receive an A.
   e. None of the above.

If I complete my homework
then I receive an A.
12. What is the negation of the following statement?
   "We have an exam on Friday and it does not cover chapter one."
   \[ \text{exam} \land \sim \text{ch.1} \]
   \[ \sim (p \land q) \equiv \sim p \lor \sim q \]
   negation: \[ \sim (\sim \text{ch.1}) \]
   \[ \equiv \sim \text{exam} \lor \text{ch.1} \]
   a. We do not have an exam on Friday and it covers chapter one.
   b. We have an exam on Friday or it does not cover chapter one.
   c. If we have an exam on Friday then it does not cover chapter one.
   d. We do not have an exam on Friday or it covers chapter one.
   e. None of the above.

13. What type of reasoning goes from specific to general?
   a. syllogism
   b. tautology
   c. deductive
   d. inductive
   e. None of the above.

14. Which of the following is equivalent to \( \sim q \land p \)?
   \[ \sim (p \rightarrow q) \equiv p \land \sim q \]
   a. \( p \rightarrow q \)
   b. \( \sim (p \rightarrow q) \)
   c. \( \sim p \lor q \)
   d. \( \sim q \rightarrow p \)
   e. None of the above.
15. Is the following a tautology?

\[(p \land q) \rightarrow (p \lor q)\]

- [ ] a. tautology
- [x] b. not a tautology
Make sure to show all of your work when needed on the following problems. Each one is worth the indicated amount of points.

1. Given the following argument:

   1. If you wear polka dots, you do not wear stripes.
   2. You wear solid colors only if you wear stripes.

   Therefore, you do not wear solid colors if you wear polka dots.

   \[ p: \text{You wear polka dots.} \]
   \[ q: \text{You wear solid colors.} \]
   \[ r: \text{You wear stripes} \]

   a. Write each part of the argument in symbolic form. (6 points)
   \[
   \begin{align*}
   1 & : p \rightarrow \sim r \\
   2 & : q \rightarrow r \\
   \therefore & : p \rightarrow \sim q \\
   \end{align*}
   \]

   b. Combine the argument together. (5 points)
   \[
   \left( p \rightarrow \sim r \right) \land \left( q \rightarrow r \right) \rightarrow \left( p \rightarrow \sim q \right)
   \]

   c. Construct a truth table to determine if the argument is valid or invalid. (9 points)
   \[
   \begin{array}{cccccccccc}
   p & q & r & \sim q & \sim r & p \rightarrow \sim r & q \rightarrow r & \sim q \land r & p \rightarrow ( \sim q \land r ) & p \rightarrow \sim q \\
   T & T & T & F & F & T & F & T & T & T \\
   T & T & F & F & F & T & F & F & T & T \\
   T & F & T & T & F & T & T & T & T & T \\
   T & F & F & T & T & T & T & T & T & T \\
   F & T & T & F & F & T & T & T & T & T \\
   F & T & F & T & F & T & F & F & T & T \\
   F & F & T & T & T & T & T & T & T & T \\
   F & F & F & T & T & T & T & T & T & T \\
   \end{array}
   \]

   Valid (Tautology)
2. Use a Venn diagram to determine if the following argument is valid or invalid. 
   (7 points)

   1. No politician lies.
   2. Some lawyers lie.

   Therefore, no politicians are lawyers.

3. Given the following statement:
   "You attend OU only if you have excellent ACT scores and did not have bad
   grades in high school."

   p: You attend OU.
   q: You have excellent ACT scores.
   r: You had bad grades in high school.

   a. Write the statement in symbolic form. (5 points)

   \[ p \rightarrow (q \land \sim r) \]

   b. Construct a truth table for the statement. (8 points)

   \[
   \begin{array}{cccc|c|c|}
   p & q & \sim r & q \land \sim r & p \rightarrow (q \land \sim r) \\
   \hline
   1. & T & T & F & F \\
   2. & T & T & T & T \\
   3. & T & F & T & T \\
   4. & T & F & F & T \\
   5. & F & T & T & T \\
   6. & F & T & F & T \\
   7. & F & F & T & T \\
   8. & F & F & F & T \\
   \end{array}
   \]