Categorical Logic Handout **with Key**
Logic: Fall 2016

Deductive argument: An argument whose premises are claimed to provide conclusive grounds for the truth of its conclusion.

Validity: A characteristic of any deductive argument whose premises, if they were all true, would provide conclusive grounds for the truth of its conclusion. Such an argument is said to be valid.

Sound: Any valid argument with true premises.

Four Categorical Claims:
A: All S are P (Universal affirmative)
E: No S are P (Universal negative)
I: Some S are P (Particular affirmative)
O: Some S are not P (Particular negative)

Quality, Quantity, and Distribution (Review earlier notes)

Exercise #1: Name the quality and quantity of each of the following propositions, and state whether their subject and predicate terms are distributed or undistributed.

1. Some presidential candidates will be sadly disappointed people.

2. All those who died in Nazi concentration camps were victims of a ruel and irrational tyranny.

3. Some recently identified unstable element were not entirely accidental discoveries.

4. Some members of the military-industrial complex are mild-mannered people to whom violence is abhorrent.

5. No leader of the feminist movement is a major business executive.

Syllogism: Any deductive argument in which a conclusion is inferred from two premises.

Categorical syllogism: A deductive argument consisting of three categorical propositions that contain exactly three terms, each of which occurs in exactly two of the propositions.

No heroes are cowards.
Some soldiers are cowards.

Therefore, some soldiers are not heroes.

Terms: There are three terms in a syllogism: the major term, the minor term, and the middle term.

Major term: The major term is the predicate of the conclusion.
Minor term: The minor term is the subject of the conclusion.
Middle term: The middle term is the term that appears in both premises, but not in the conclusion.

The Principles of the Syllogism: Categorical syllogisms state the identity of two terms, the minor and major terms, by virtue of their mutual identity with a third term, the middle term. Behind the rules that govern the syllogism, there are four principles which are fundamental to all logical thought.

1. The Principle of Reciprocal Identity: *Two terms that are identical with a third term are identical to each other.* For example, in the argument, "All men are mortal. Socrates is a man. Therefore, Socrates is mortal," the term *mortal* is said to be identical with the term *man;* and the term *mortal* is also said to be identical to the term *Socrates.* Since both *Socrates* and *man* are identical to *mortal,* then the terms *Socrates* and *man* must be identical to each other. In other words, if S is identical with M and P is identical with M, then S is identical to P.

2. The Principle of Reciprocal Non-Identity: *Two terms, one of which is identical with a third term and the other of which is nonidentical with that third term, are nonidentical to each other.* Consider the following argument:

No men are angels.
Socrates is a man.
Therefore, Socrates is not an angel.

We see here that although *Socrates* is said to be identical with *man, angel* is not identical with *man.* Since *Socrates* is identical with *man* but *angel* is not, *Socrates* cannot be identical with *angel.* In other words, if S is identical with M, but P is not identical with M, then S is not identical with P.

3. The Dictum de Omni: *What is affirmed universally of a certain term is affirmed of every term that comes under that term.* This principle is apparent also in our original syllogism. Since mortality is affirmed universally of man, every term that comes under the extension of *man* shares in it. Since Socrates is included in the extension of *man,* Socrates is said to share in mortality.

4. The Dictum de Nullo: *What is denied universally of a certain term is denied of every term that comes under that term.*
Consider the following argument:

No man is God.
Socrates is a man.
Therefore, Socrates is not God.

The argument denies divinity universally of men. Since *Socrates* comes under *men,* it is denied of Socrates too.

Exercise #2:

1. Explain how to distinguish each of the following: Major term, minor term, middle term.

2. In a syllogism, which is the major premise?

3. In a syllogism, which premise is the minor premise?

In the following syllogisms, indicate the major premise, and the minor premise by writing major or minor next to the appropriate premise. Indicate also the minor, major and middle terms by writing them out and writing S next to the minor term, a P next to the major term, and an M next to the middle term.

4. All men are mortal.
   Socrates is a man.
   Therefore, Socrates is mortal.

5. All logic problems are difficult.
   This problem is a logic problem.
   Therefore, this problem is difficult.

6. All good basketball players can shoot well.
   Steph Curry is a good basketball player.
   Therefore, Steph Curry can shoot well.

7. No men are gods.
   Socrates is a man.
   Therefore, Socrates is not a god.

8. All apostles are men.
   Peter is an apostle.
   Therefore, Peter is a man.

9. No beliefs that conflict with the Bible are true.
   The belief that the world was created by chance conflicts with the Bible.
   Therefore, the belief that the world was created by chance is not true.`

Exercise #3: Indicate whether the following syllogisms illustrate the Principle of Reciprocal Identity (PRI) or the Principle of Reciprocal Non-Identity (PRNI) and the Dictum de Omni (DO) or the Dictum de Nullo (DN). (Be aware that a syllogism can illustrate both PRI or PRNI (but not both) and DO or DN (but not both). (Use the examples (4-9) above.

True or False

T	F	The two kinds of reasoning are deduction and induction.
T	F	A syllogism contains three premises and a conclusion.
T	F	In a valid argument, if the premises are true, the conclusion must be true.
T	F	The minor term is the subject of the conclusion and the major term is the predicate of the conclusion.
T	F	The major premise is the premise that contains the major term.
T	F	The middle term is the term that does not appear in either premise.
T	F	If S is identical with M and P is identical with M, then S is identical with P.

Figure and Mood of Syllogisms

Mood: Each sentence occurring in a categorical syllogism is a categorical proposition, each is one of four forms A, E, I O. The mood of a syllogism is indicated by the three letters representing the forms of the major premise, minor premise, and the conclusion in that order. For example:

No P is M	E
All S is M	A
Therefore, Some S is not P	O

Has the mood EAO.

Figure: The *figure* of a syllogism represent the pattern of occurances of the middle term in the syllogism. There are four figures.

	1st Figure		2nd Figure		3rd Figure		4th Figure	
Major premise	M	P	P	M	M	P	P	M
Minor premise	S	M	S	M	M	S	M	S

The combination of mood and figure gives a complete classification of the logical forms of categorical syllogisms. The standard way of representing a categorical syllogism is by writing its mood followed by its figure; for example, AII-3 is a syllogism of the form

All M is P
Some M is S
Therefore, some S is P.

Exercise #4: Use the syllogisms 4-8 used for Ex. #3 and identify the mood and figure for each.

1. _____ 2. _____ 3._____ 4. _____ 5. _____

Rules for Categorical Syllogisms

There are seven rules of validity for categorical syllogisms.

Terminological Rules
I. There must be three and only three terms.
II. The middle term must not occur in the conclusion.

Quantitative Rules
III. If a term is distributed in the conclusion, then it must be distributed in the premises.
IV. The middle term must be distributed at least once.

Qualitative Rules
V. No conclusion can follow from two negative premises.
VI. If the two premises are affirmative, the conclusion must also be affirmative.
VII. If either premise is negative, the conclusion must be negative.

The following is an error related to rule **I.** It is called the *fallacy of four terms.*

All mammals have hair.
All horses have manes.
Therefore, some mammals have hair.

Another example of an error. It is called the fallacy of equivocation:

All planes are two-dimensional.
All Boeing 747s are planes.
Therefore, all 747s are two-dimensional.

An example of an error regarding rule **II.**

All plants are living things.
All animals are living things.
Therefore, all living things are plants or animals.

Exercise #5.

1. How many of these rules does a syllogism have to comply with in order to be considered valid?

2. Why are the first two rules called *terminological* rules?

3. Tell whether the following syllogisms are examples of the Fallacy of Four Terms (FFT) or the Fallacy of Equivocation (FE):

All wildebeasts are mammals.
All lions are felines.
Therefore, all felines are mammals.

All mice eat cheese
Some computer parts are mice.
So some computer parts eat cheese.

All animals are irrational.
All dogs are mammals.
Therefore, all mammals are irrational.

All kings are powerful.
No queens are men.
Therefore, some men are powerful.

All accidents are life-threatening.
This new recipe was an accident.
Therefore, this new recipe is life-threatening.

All aliens are from outer space.
All foreigners are aliens.
So, foreigners are from outer space.

All banks contain money.
All rivers have banks.
There fore, all rivers contain money.

All roses have thorns.
All flowers are beautiful.
So, beautiful things have thorns.

4. Indicate whether the syllogisms below violate Rule II. (Yes or No)

All lions are felines.
All felines are animals.
Therefore, some felines are lions.

All animals are living beings.
All mice are animals.
Therefore, all mice are living things.

All animals are irrational.
All horses are animals.
Therefore, all horses are irrational.

Some men are kings.
All kings are powerful.
Therefore, some kings are men.

All things life-threatening should be avoided.
All accidents are life-threatening.
Therefore, all accidents should be avoided.

All aliens are supposed to be registered.
All foreigners are aliens.
Therefore, all foreigners are supposed to be registered.

All that contain water are wet.
All rivers contain water.
Therefore, all rivers are wet.

All flowers are beautiful.
All beautiful things should be admired.
Therefore, some beautiful things have flowers.

In the following syllogisms indicate the major premise (**major)**, the minor premise (**minor).** Indicate the minor, major, and middle terms by using S, P, and M. Determine whether the syllogism is valid or invalid. If it is invalid, tell whether it

violates Rule I or Rule II. (Hint: if you have a hard time determining the minor and major terms, it is probably because it violates one of these rules):

A horse is a quadruped.
All mammals breathe oxygen.
Therefore, some mammals are quadrupeds.

All Romans were brave.
Julius Caesar was a Roman.
Therefore, Julius Caesar was brave.

All horses are fast.
Secretariat is a horse.
Therefore, some horses are fast.

All food should be eaten.
This logic problem is food for thought.
Therefore, this logic problem should be eaten.

Discussion of Quantitative Rules: These are called *quantitative* because they have to do with the quantity of the statements in a syllogism. The quantity of a statement has to do with whether the statement is universal or particular.

Review of *distribution* (See earlier class notes.)
Distribution is the status of a term in regard to extension.

Example for analysis:
All angels are spiritual beings.
No men are angels.
Therefore, no men are spiritual beings.

Syllogisms that violate Rule III are said to commit the *Fallacy of Illicit Process.* There are two ways the fallacy is committed. The first is called the *Fallacy of Illicit Major* and the second is called the *Fallacy of Illicit Minor.*
The Fallacy of Illicit Major occurs when the major term (the predicate of the conclusion) is distributed in the conclusion, but not in the major premise.
The Fallacy of Illicit Minor occurs when the minor term (the subject of the conclusion) is distributed in the conclusion, but not in the minor premise. An example of the Fallacy of Illicit Minor is:

All men are animals.
All men are mortal
Therefore, all mortals are animals.

Because the middle term, *spiritual beings,* is not distributed in either premise, it cannot serve to connect the minor and major terms. When this occurs, we have committed the *Fallacy of Undistributed Middle.*

Exercise #6: Mark the following syllogisms indicating the minor, major, and middle terms (S, P, and M). Indicate whether the term is distributed or undistributed (*d* or *u*). (Note that negative statements in which the subject term is a proper noun are E statements. For example, "Jeff is not rude" is "No S is P.")

All boys___are human___.
Nathaniel___is a boy___.
Therefore, Nathaniel___is human___.

No truth___is simple___.
Hinduism___is the truth___.
Therefore, Hinduism___is not simple___.

No boys___are rude___.
Jeff___is a boy___.
Therefore, Jeff___is not rude___

All Romans___are brave___.
Caesar___is a Roman___.
Therefore, Caesar___is brave___.

All cars___are fast___.
A Corvette___ is a car___
Therefore, a Corvette___is fast___.

All generals___are great___
Hannibal___is a general___.
Therefore, Hannibal___is great___.

All girls___ are smart___.
Suzy___ is a girl___
Therefore, Suzy___ is smart___.

No wars___ are fun___.
World War II___ was a war____.
Therefore, WWII___ was not fun___.

Identify the rule that is violated in the following syllogisms. Indicate minor, major, and middle terms (S, P, and M) and whether the terms are distributed or undistributed (d and u). If Rule III is violated, indicate which fallacy is commetted, Illicit Major (IMj) or Illicit Minor (IMn). If no fallacy is committed, mark NF.

All boys are human.
No girls are boys.
Therefore, no girls are human.

All towns are safe.
Jerusalem has high walls.
Therefore, Jerusalem is safe.

All victories are glorious.
No defeat is a victory.
Therefore, no defeat is glorious.

All Gorgons have snakey hair.
All Gorgons are sisters.
Therefore, al sisters have snakey hair.

All men are animals.
All men are mortal.
Therefore, all mortals are animals.

All Southerners eat grits.
No Yankee is a Southerner.
Therefore, no Yankee eats grits.

All cars are fast.
My car is a Corvette.
Therefore, my car is fast.

All Romans are brave.
No Gaul is a Roman.
Therefore, all brave men are great.

Practicing the Qualitative Rules: These are called *qualitative* because they have to do with the quality of the statements in a syllogism. The quality has to do with whether the statement is affirmative or negative.

Example violating Rule V. (*Fallacy of Exclusive Premises*).

No plants are animals.
Some minerals are not animals.
Therefore, some minerals are not plants.

Example violating Rule VI (*Fallacy of Drawing a Negative Conclusion from Affirmative Premises.*)

All men are mortals.
All mortals make mistakes.
Therefore, some things that make mistakes are not men.

Example violating Rule VII (*Fallacy of Drawing an Affirmative Conclusin from a Negative Premise.*)

All cannibals are bloodthirsty.
Some accountants are not bloodthirsty.
Therefore, some accountants are cannibals.

Exercise #7: Indicate which rule is violated. Indicate minor, major, and middle terms (S, P, and M) and whether the terms are distributed (d and u) Just identify which rule is violated (I – VII). If no fallacy is committed, then simply mark it valid.

No saints are villains.
Some robbers are not villains.
Therefore, some robbers are saints.

Some vegetables are not sweet.
No vegetable is a fruit.
Therefore, some fruits are not sweet.

All floods are devastating.
No drought is a flood.
Therefore, no drought is devastating.

All symphonies are beautiful.
No opera is a symphony.
Therefore, no opera is beautiful.

All Protestants believe in the trinity.
All Catholics believe the trinity.
Therefore, some Catholics are Protestant.

No maples are pines.
No oaks are pines.
Therefore, no oaks are maples.

No Greeks are Romans
Some soldiers are not Romans.
Therefore, some soldiers are not Greeks.

No man is as wise as Solomon.
Einstein is a man.
Therefore, Einstein is not as wise as Solomon.

KEY

Exercise #1

1. PA/uu
2. UA/du
3. PN/ud
4. PA/uu
5. UN/dd

Exercise #2

1. The major term is the predicate term of the conclusion. The minor term is the subject of the conclusion. The middle term is the term that appears in each of the premises, but not in the conclusion. *Note that we use S to indicate the minor term and P to indicate the major term. This is because all three terms start with "m."*

2. The major premise is the premise that contains the major term. In standard form, it is always the first premise.

3. The minor premise is the premise that contains the minor term. In standard form, it is always the second premise.

4.
M P
All men are mortal. Major premise
S M
Socrates is a man. Minor premise
S P
Socrates is mortal. *We will dispense with "therefore" for these exercises. The third sentence is always the conclusion.*
The above argument is AAA-1

5.
M P
All logic problems are difficult. Major premise
S M
This problem is a logic problem. Minor premise
S P
This problem is difficult. AII-1

6.
M P
All good basketball players can shoot well. Major premise
S M
Steph Curry is a good basketball player. Minor premise
S P
Steph Curry can shoot well. AAA-1

M P
7. No men are gods. Major premise
S M
Socrates is a man. Minor premise
S P
Socrates is not a god. EAO-1

M P
8. All apostles are men. Major premise
S M
Peter is an apostle. Minor premise
S P
Peter is a man. AAA-1

M P
9. No beliefs that conflict with the Bible are true. Maj. P.
S M
The belief that the world was created by chance conflicts with the Bible. Min.
S P
The belief that the world was created by chance is not true. EIO-1

Exercise #2 (Refer to the previous examples, 4-9.)

4. PRI DO
5. PRI DO
6. PRI DO
7. PRNI DN
8. PRI DO
9. PRNI DN

<u>True or False</u>
True
False
True
True
True
False
True

Exercise #4
Answers are next to each example, 4-8 above.

Exercise #5
1. All seven
2. Because they have specifically to do with the terms in a syllogism.

3. (We will go left to right, left to right, starting with “All wildebeasts…”, then “All mice…” etc.)

FFT	FE
FFT	FFT
FE	FE
FE	FFT

4.

Y	N
N	Y
N	N
N	Y

(3) P
A horse is a quadruped. Rule 1, FFT
S (4)
All mammals breathe oxygen.
S P
Some mammals are quadrupeds.

M P
All Romans were brave. AAA-1 Valid
S M
Julius Caesar was a Roman.
S P
Julius Caesar was brave.

M P
All horses are fast Rule II
(S) M
Secretariat is a horse.
M P
Some horses are fast.

M P
All food should be eaten Rule 1 FE
S M
This logic problem is food for thought.
S P
This logic problem should be eaten.

Exercise #6 on next page.

Exercise #6

AAA-1 valid
M(d) P(u)
S(d) M(u)
S(d) P(u)

EAE-1 valid
M(d) P(d)
S(d) M(u)
S(d) P(d)

EAE-1 valid
M(d) P(u)
S(d) M(u)

AAA-1 valid
M(d) P(u)
S(d) P(u)

AAA-1 valid
M(d) P(u)
S(d) M(u)
S(d) P(u)

AAA-1 valid
M(d) P(u)
S(d) M(u)
S(d) P(u)

AAA-1 valid
M(d) P(u)
S(d) M(u)
S(d) P(u)

EAE-1 valid
M(d) P(d)
S(d) M(u)
S(d) P(d)

Part 2 of Exercise #6

AAA-3 Rule III
M(d) P(u)
S(s) M(d)
S(d) P(d)

FFT
(3)(d) P(u)
S(d) (4)(u)
S(d) P(u)

AOO-1 Rule III
M(d) P(u)
S(d) M(d)
S(d) P(d)

AAA-3 Rule III
M(d) P(u)
M(d) S(u)
S(d) P(u)

AAA-3 Rule III
M(d) P(u)
M(d) S(u)
S(d) P(u)

AEE-1 Rule III
M(d) P(u)
S(d) M(d)
S(d) P(d)

FFT
(3)(d) P(u)
S(u) (4)(u)
S(u) P(u)

FFT
M(d) (3)(u)
(4)(d) M(u)
S(d) P(u)

Exercise #7

EOI-2 Rule V
P(u) M(d)
S(u) M(d)
S(u) P(u)

OEO-3 Rule V and Rule VII
M(u) P(d)
M(d) S(d)
S(u) P(d)

AEE-1 Rule III
M(d) P(u)
S(d) M(d)
S(d) P(d)

AEE-1 Rule III
M(d) P(u)
S(d) M(d)
S(d) P(d)

AAI-2 Rule IV
P(d) M(u)
S(d) M(u)
S(u) P(u)

EEE-2 Rule V
P(d) M(d)
S(d) M(d)
S(d) P(d)

EOO-3 Rule V and Rule VII
P(d) M(u)
S(u) M(u)
S(u) P(d)

EAE-1 Valid
M(d) P(d)
S(d) M(u)
S(d) P(d)