Directions: The following exam consists of 54 questions, for a total of 0 points and 0 bonus point. Read each question carefully (note: answers may break onto the next page). This exam tests your knowledge over the material from Chapter 1 and Chapter 2 of *Symbolic Logic: Syntax, Semantics, and Proof* and any additional handouts or discussion generated from this text. While you may write on the test itself, please place your name and final answers on the "answer sheet" found on the last page of this exam. You may use the back of the "answer sheet" as scrap paper.

For each question, choose one and only one (the best) answer (unless the question states otherwise).

1 Chapter 1

1.1 Definitions and Concepts

1. (2 points) What is an argument?
    A. An argument is a series of sentences in which a certain sentence comes after another set of sentences.
    B. An argument is a series of propositions in which a certain proposition (the conclusion) is represented as "following from" another set of propositions (the premises or assumptions).
    C. An argument is a proposition, sometimes multiple propositions.
    D. An argument is a series of sentences (some of which express propositions) in which a certain sentence comes after another set of sentences.

2. (2 points) In the context of logic, what is a proposition?
    A. A proposition is a sentence of any kind.
    B. A proposition is an argument.
    C. A proposition is an implied threat, e.g., "your money or your life."
    D. A proposition is something (typically expressed by a sentence) that is capable of being true or false.
    E. A proposition is a sentence (or something that is expressed by a sentence) that is known to be true or known to be false.

3. (2 points) Which of the following are **not** propositions? (indicate all that apply). You should read each sentence literally.
    A. Close the door, right now.
    B. This room is located in the United States.
    C. Joe Biden is the current president of the USA.
    D. Tomorrow is the day after today.
    E. Where is the bathroom?

4. (2 points) Indicate the best definition of deductive validity.
    A. An argument is valid if and only if it is logically impossible for its premises to be true and its conclusion false.
    B. An argument is valid if and only if it is logically possible for its conclusion to be true and its premises false.
    C. A set of propositions are valid if and only if all of the propositions can be true
    D. An argument is valid if and only if it is logically impossible for the conclusion to be true and its premises false.

5. (2 points) Which of the following best describes the **intuition test** for deductive validity.

   A. Examine the argument, if you get a feeling that the argument is valid, then the argument is valid.

   B. Consider each possible interpretation of the propositional letters in the argument, then use the valuation rules to determine the truth value of each proposition. Finally, check to see if under any of the interpretations, the valuation rules show the premises true and the conclusion is false.

   C. Try to imagine a scenario where the premises are true and the conclusion is false. If you can imagine such a scenario, then the argument is not deductively valid. If you cannot imagine such a scenario, then the argument is deductively valid.

   D. It is an algorithm that mechanically checks each and every premise for truth, then checks the conclusion for falsity.

6. (2 points) Which of the following best describes the **imagination test** for deductive validity.

   A. Try to imagine a scenario where the premises are true and the conclusion is false. If you can imagine such a scenario, then the argument is not deductively valid. If you cannot imagine such a scenario, then the argument is deductively valid.

   B. Try to imagine a scenario where the premises are true and the conclusion is false. If you can imagine such a scenario, then the argument is deductively valid. If you cannot imagine such a scenario, then the argument is not deductively valid.

   C. You simply imagine a scenario where the argument seems right and makes sense according to everyday reasoning. If the argument "feels" right, then it is valid. If the argument "feels" wrong, then it is not valid.

   D. You imagine a scenario where the argument seems right and makes sense according to everyday reasoning and facts given to us from science. If the argument "feels" right, then it is valid. If the argument "feels" wrong, then it is not valid.

   E. You imagine a scenario where the argument seems right and makes sense according to everyday reasoning and facts given to us from science, tradition, and common sense. If the argument "feels" right, then it is valid. If the argument "feels" wrong, then it is not valid.

7. (2 points) Which of the following definitions best captures what it means for an argument to be "sound"?

   A. an argument is sound if and only if it has all true premises and is a valid argument.

   B. an argument is sound if and only if it is a valid argument.

   C. an argument is sound if and only if it has all true premises.

   D. an argument is sound if and only if it has all true premises, is a valid argument, and is practically beneficial to human beings.

   E. an argument is sound if and only if it has all true premises, is a valid argument, and where the conclusion does not express anything that might be viewed as controversial.

8. (2 points) Suppose it is logically impossible for an argument's premises to be true. That is, the argument is such that the premises are always false. Is this argument valid or invalid?

   A. invalid

   B. valid

   C. it will depend upon the truth of the conclusion; if the conclusion is false, then the argument is invalid; if the conclusion is true, then the argument is valid.

   D. it will depend upon the truth of the conclusion; if the conclusion is true, then the argument is invalid; if the conclusion is false, then the argument is valid.

9. (2 points) Suppose it is impossible for an argument's conclusion to be false. Is this argument valid or invalid?

    A. invalid

    B. valid

    C. it will depend upon the truth of the premises; if the premises are false, then the argument is invalid; if the premises are true, then the argument is valid.

    D. it will depend upon the truth of the premise; if the premises are true, then the argument is invalid; if the premises are false, then the argument is valid.

2 Chapter 2

2.1 PL: Symbols

10. (2 points) Which of the following are **not** symbols in **PL** (indicate all that apply, using only those symbols specified in our textbook / handouts)?

    A. P

    B. &

    C. $\wedge$

    D. $\rightarrow$

    E. $\leftrightarrow$

    F. $\uparrow$

2.2 Syntax

2.2.1 Wffs

Directions: Determine which of the following are well-formed formulas (wffs) in PL. If a formula is a wff, write "wff" on the line provided. If it is not a wff, then write "not a wff". In determining whether a formula is a wff, use the *relaxed* definition of a wff, viz., the one that is determined by the formation rules for **PL** and the conventions used for simplifying formulas.

11. (2 points) $\neg Q \neg W$

12. (2 points) $P \uparrow Q$

13. (2 points) $\neg\neg M$

14. (2 points) $\neg(P \rightarrow Q)$

15. (2 points) $\neg\neg\neg P \rightarrow Q$

16. (2 points) $(A \rightarrow S) \vee (B \wedge C)$

2.2.2 Parts, subformulas, scope, main operator

17. (2 points) Consider the following wff: $\neg P \vee Q$. List all of the **proper parts** of this wff on the line provided.

18. (2 points) Consider the following wff: $\neg(P \wedge Q)$. List all of the **subformulas** of this wff on the line provided.

19. (2 points) True or false. If $\neg P$ is a wff, then $\neg P$ is a proper part of that wff.

20. (2 points) Which of the following is the best definition for the main operator of a wff in **PL**?
    A. The main operator of a **PL** wff is propositional letter with the greatest scope.
    B. The main operator of a **PL** wff is the furthest left and right set of parentheses.
    C. The main operator of a **PL** wff is always either the negation $\neg$ or the wedge $\wedge$
    D. The main operator of a **PL** wff ϕ is the truth-functional operator whose scope is ϕ (the entire wff).
    E. The main operator of a **PL** wff is the operator that has the least or smallest scope.

Directions: Write the main operator of the following wffs on the line provided. Some of the wffs may be written using the conventions for simplifying wffs.

21. (2 points) $(P \vee S)$

22. (2 points) $\neg(X \rightarrow Y)$

23. (2 points) $(\neg M \leftrightarrow \neg Z)$

24. (2 points) $\neg S \wedge (A \vee B)$

25. (2 points) $P \leftrightarrow \neg(\neg Q \vee \neg R)$

2.2.3 Literal Negation

Directions: Write the literal negation of the following wffs.

26. (2 points) Q

27. (2 points) $P \rightarrow Q$

28. (2 points) $\neg M \vee W$

2.2.4 Types of Wffs

Directions: Write the name of the following complex wffs on the line provided (e.g. conjunction, disjunction, conditional, biconditional, or negation)

29. (2 points) $P \vee \neg Q$

30. (2 points) $\neg P \wedge Q$

31. (2 points) $P \rightarrow \neg Q$

2.3 Semantics

32. (2 points) What is an interpretation in **PL**?
    A. An interpretation of **PL** is a function that takes wffs as input and assigns them them a single truth value (T or F) as output.
    B. An interpretation of **PL** specifies the meaning of a wff by telling us what ideas or images or associations it evokes in human agents.
    C. An interpretation of **PL** specifies the meaning of a wff by telling us what objects in the world that the wff refers.
    D. An interpretation of **PL** specifies the meaning of a wff by assigning a wff a truth value T for true, F for false, or I for indeterminate.
    E. An interpretation of **PL** is a function that takes propositional letters as input and assigns them a single truth value (T or F) as output.

33. (2 points) What is the main difference between an interpretation in **PL** and a valuation in **PL**?
    A. An interpretation of **PL** assigns truth values to propositional letters while a valuation assigns truth values to wffs.
    B. An interpretation of **PL** gives meaning to parentheses while a valuation does not.
    C. An interpretation of **PL** allows for determining the main operator of a wff while a valuation does not.
    D. An interpretation of **PL** assigns truth values to wffs while a valuation assigns truth values to propositional letters.
    E. An interpretation of **PL** assigns truth values to conjunctions while a valuation assigns truth values to negated wffs and conditionals.

Directions: Determine the truth value for each of the following formulas given the following interpretation: $\mathscr{I}(Q) = T$, $\mathscr{I}(M) = T$, $\mathscr{I}(P) = F$

34. (2 points) Q
35. (2 points) $Q \vee P$
36. (2 points) $M \vee P$
37. (2 points) $M \wedge P$
38. (2 points) $P \rightarrow M$
39. (2 points) $M \leftrightarrow P$

2.4 Translations

Directions: Translate the following well-formed formulas (wffs) from the language of propositional logic (PL) into English. Use the following translation key:
T = Tek is tall, A = Tek is angry, H = Hikaru is tall, O = Olga is happy, R = Rei is happy, K= Tek is happy.

40. (2 points) $\neg T$
41. (2 points) $T \rightarrow H$
42. (2 points) $O \rightarrow R$

43. (2 points) $(T \vee H) \vee O$

44. (2 points) $T \leftrightarrow H$

Directions: Translate the following English propositions into well-formed formulas (wffs) in the language of propositional logic (PL) capturing as much of the logical structure of the sentences as possible. Use the translation key provided above.

45. (2 points) Olga is happy and Tek is happy.

46. (2 points) If Rei is happy, then Tek is happy.

47. (2 points) It is neither the case that Rei is happy nor Tek is happy.

48. (2 points) Tek is not both happy and angry.

49. (2 points) Tek is angry only if Tek is tall.

50. (2 points) Tek is tall even if Tek is angry.

3 Extra Credit

51. Which one of the following is not correct
    A. The main operator of $\neg(P)$ is $\neg$
    B. The main operator of $(P \wedge Q)$ is $\wedge$
    C. The main operator of $\neg P \wedge Q$ is $\neg$
    D. The main operator of $\neg P \rightarrow Q$ is $\neg$

52. Translate $(P \vee Q) v R$ in English where P = Peter is happy, Q = Quentin is sad, and R = Regan is angry.

53. Let $\mathscr{I}(P) = T, \mathscr{I}(Q) = T, \mathscr{I}(R) = F$. Given this interpretation, what is the truth value of $(P \vee \neg Q) \wedge R$?

54. Suppose that the principle of bivalence is false and that propositional letters receive three truth values instead of two (T, F, and I, with I being indeterminate). Create a valuation function for $P \wedge Q$ now that there are three truth values.

Congratulations! You did it!

- turn in your exam and answer sheet at the front of the classroom,
- check to see if your homework has been graded,
- feel free to leave.

Directions: Remove this page from the exam. This page is your answer sheet. Please write your **name** on the top of the page and please write clearly. This page is specifically correlated to your exam so do not exchange your exam with your neighbor. **3Uv2x3**

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____
22. _____
23. _____
24. _____
25. _____
26. _____
27. _____
28. _____
29. _____
30. _____
31. _____
32. _____
33. _____
34. _____
35. _____
36. _____
37. _____
38. _____
39. _____
40. _____
41. _____
42. _____
43 _____
44 _____
45 _____
46 _____
47 _____
48 _____
49 _____
50 _____