Homework #2
(50 points)

Due Date: January 29th, 2021, at the beginning of class

Directions

1. **This is an INDIVIDUAL assignment; do your own work! Submitting answers created by other people is NOT doing your own work.**

2. Start early! Getting help is much easier five days before the due date/time than it will be five hours before.

3. These questions are over material covered in both the Rosen text (sections 1.1, 1.2, and 1.3) and “Kneel Before Zodd” (Chapter 1), both accessible from D2L, as well as in our class meetings.

4. Write complete answers to each of the following questions, in accordance with the given directions. Create your solutions as a PDF document such that each question is on a separate page; all parts of a multi-part question may be on the same page. Show your work, when appropriate, for possible partial credit.

5. If you have questions about any aspect of this assignment, help is available from the class staff via piazza.com and our Zoom office hours.

6. When your answers are ready to be turned in, do so on gradescope.com. The entry code is 74DKZK, should you need it. Be sure to assign pages to problems after you upload your PDF. Need help? Visit https://help.gradescope.com/ and search for “Submitting an Assignment.”

7. **Solutions submitted after the first five minutes of class on the due date will not be accepted.**

Rosen, Section 1.1:

1. (2 points) For each of the following, which are propositions, and, for those that are propositions, are they true or false?
   
   (a) There are no black flies in Maine.
   
   (b) The moon is made of green cheese.

2. (2 points) Write, in English, the negation of each of these propositions.

   (a) There are 13 items in a “baker’s dozen.”

   (b) 121 is a perfect square.

3. (4 points) For each of the following sentences, which are expressing *inclusive* disjunction and which are expressing *exclusive* disjunction? Briefly justify your answers.

   (a) The stuntman is experienced or reckless.

   (b) 4 or 6 is adjacent to 5 on the integer number line.
4. (4 points) Construct a complete truth table for each of the following logical expressions. Be sure to order the rows as shown in class, and to have (at least) one column per operator in the expression.

(a) \( \neg p \land (\neg q \oplus p) \)
(b) \( r \lor (p \land r) \lor (q \land r) \)

5. (4 points) Assume \( p \) is the proposition “I bought a lottery ticket this week”, and \( q \) is the proposition “I won the million dollar jackpot”. Express each of the following propositions as an English sentence.

(a) \( p \lor q \)
(b) \( \neg p \lor (p \land q) \)

6. (4 points) Consider these propositions: \( p \): You have the flu, \( q \): You miss the final examination, and \( r \): You pass the course. Express each of these propositions as sentences in English.

(a) \( p \lor q \lor r \)
(b) \( (p \land q) \lor (\neg q \land r) \)

7. (4 points) In English, write a compound proposition that describes . . .

(a) . . . the possible ways to order the two cards Ace of Clubs and Ace of Hearts.
(b) . . . the ways a student could be enrolled in the CSc 245 lecture and one of its three problem-solving sessions this semester.

8. (4 points) Evaluate each of the following bit–wise logical expressions.

(a) \(11000 \land (01011 \lor 11011)\)
(b) \( (01010 \oplus 11011) \oplus 01000 \)

9. (4 points) Evaluate each of the following Java bit–wise logical expressions, assuming 5–bit signed integer values. Give your answers as decimal integers.

(a) \(3 \mid 12 \) (Reminder: In Java, \( \mid \) is OR.)
(b) \( 10 \land \sim 7 \) (Reminder: In Java, \( \land \) is XOR.)

Rosen, Section 1.2:

10. (2 points) Express the following English sentence as a well–formed compound proposition using the appropriate logical operators.

The user has paid the subscription fee, but has not entered a valid password.

11. (2 points) An explorer is captured by a group of logical cannibals. There are two types of cannibals — those who always tell the truth and those who always lie. The cannibals will slowly braise the explorer unless he can determine whether a particular cannibal always lies or always tells the truth. He is allowed to ask the cannibal exactly one question. Explain why the question “Are you a liar?” will not save the explorer.

Rosen, Section 1.3:

12. (2 points) Construct a truth table to show that \( (p \land q) \land r \equiv p \land (q \land r) \).

(Continued . . .)
13. (4 points) The “dual” of a compound proposition that contains only the logical operators \( \lor \), \( \land \), and negation is the compound proposition obtained by replacing each \( \lor \) by \( \land \), each \( \land \) by \( \lor \), each true by false, and each false by true. The dual of \( s \) is denoted by \( s^* \).

(a) Find the dual of \((p \land \neg q) \lor (q \land F)\).
(b) In general, when will \( s^* = s \), where \( s \) is a compound proposition? (Note that the question is using an equals sign, not the equivalence symbol.)

14. (4 points) Find a proposition in terms of \( p \) and \( q \) that is logically equivalent, but not equal, to each of the following propositions.

(a) \( q \)
(b) \( \neg p \rightarrow q \)

15. (4 points) The Rosen text introduces the concept of satisfiability in section 1.3.5. Read that section, then answer this question: Is the following expression satisfiable? Explain how you arrived at your answer.

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