You must show your work on all questions to qualify for credit. On multiple-choice questions, be sure to choose the letter corresponding to your answer now; I will not change your grade later if you have worked the problem correctly but chosen the wrong letter.

1.) What is the connective in the statement “Today is Tuesday or this is Belgium”?

2.) What is the connective in the statement “Jack likes snakes, but Jill doesn’t”?

3.) What is the connective in the statement “If all else fails, read the instructions”?

4.) Let \( p \) be the statement “Love is a thing that can never go wrong,” and let \( q \) be “I am Marie of Rumania.” Then the statement “Love is a thing that can never go wrong, and I am Marie of Rumania” is symbolized by

(a) \( p \land q \)
(b) \( p \lor q \)
(c) \( p \rightarrow q \)
(d) \( \sim q \rightarrow \sim p \)

5.) Let \( p \) be the statement “Love is a thing that can never go wrong,” and let \( q \) be “I am Marie of Rumania.” Then the statement “Love is a thing that can never go wrong, or I am Marie of Rumania” is symbolized by

(a) \( p \land q \)
(b) \( \sim (p \rightarrow q) \)
(c) \( \sim q \rightarrow \sim p \)
(d) \( p \lor q \)

6.) Let \( p \) be the statement “Love is a thing that can never go wrong,” and let \( q \) be “I am Marie of Rumania.” Then \( \sim p \rightarrow \sim q \) expresses which of the following statements?

(a) If love is not a thing that can never go wrong, then I am Marie of Rumania.
(b) If I am not Marie of Rumania, then love is a thing that can never go wrong.
(c) If love is not a thing that can never go wrong, then I am not Marie of Rumania.
(d) If love is a thing that can never go wrong, then I am Marie of Rumania.
7.) Let $p$ be the statement “Love is a thing that can never go wrong,” and let $q$ be “I am Marie of Rumania.” Then $\sim p \land q$ expresses which of the following statements?

(a) Love is a thing that can never go wrong, and I am not Marie of Rumania.
(b) Love is not a thing that can never go wrong, and I am Marie of Rumania.
(c) Love is a thing that can never go wrong, and I am Marie of Rumania.
(d) If love is not a thing that can never go wrong, then I am Marie of Rumania.

8.) Which of the following statements is the contrapositive of the statement “If I don’t go, I won’t get there”?

(a) If I get there, then I went.
(b) If I don’t get there, I didn’t go.
(c) If I don’t go, I’ll get there.
(d) If I go, I’ll get there.

9.) Which of the following statements is equivalent to the negation of the statement “If something can go wrong, it will”?

(a) If something can’t go wrong, it won’t.
(b) If something goes wrong, it could have gone wrong.
(c) Nothing can go wrong, but something will anyway.
(d) Something can go wrong, but it won’t.

10.) Make a truth table for the statement $(p \land \sim q) \rightarrow \sim p$.

11.) State DeMorgan’s Laws.

12.) Make the truth tables for $\sim (p \rightarrow q)$ and $\sim p \lor q$. What is the logical relation between the two?

13.) Use a truth table to determine whether the statement $[\sim (p \land (p \lor q)) \rightarrow q$ is a tautology.

14.) Which of the following statements is the contrapositive of the statement “If you pass this course, then I’m Marie of Rumania?”

(a) If I’m not Marie of Rumania, then you won’t pass this course.
(b) If you don’t pass this course, then I’m not Marie of Rumania.
(c) If I’m Marie of Rumania, then you’ll pass this course.
(d) Either you won’t pass this course, or I’m Marie of Rumania.

15.) Use a truth table to determine whether the following argument is valid.

$$
\begin{align*}
p & \rightarrow q \\
q & \lor r \\
\therefore p & \lor r
\end{align*}
$$
16.) Determine whether \( p \lor \sim q \) is logically equivalent to \( \sim (p \land \sim q) \).

17.) Which of the following is the negation of “It is winter and it is not cold”?

(a) Either it isn’t winter, or it is not cold.
(b) If it isn’t winter, then it is cold.
(c) Either it isn’t winter, or it is cold.
(d) It isn’t winter, and it is cold.
(e) It is winter, but it is cold.

18.) Which of the following is the negation of “Either John likes Mary, or Ellen is wrong”?

(a) John likes Mary, but Ellen is wrong.
(b) If John doesn’t like Mary, then Ellen is right.
(c) John doesn’t like Mary, and Ellen is right.
(d) Either John doesn’t like Mary, or Ellen is right.

19.) Which of the following is equivalent to the negation of “Now is the winter of our discontent made glorious summer by this sun of York; and all the clouds that lour’d upon our house in the deep bosom of the ocean buried”?

(a) Now is the winter of our discontent not made glorious summer by this sun of York; or, not all the clouds that lour’d upon our house are buried in the deep bosom of the ocean.
(b) Now is the winter of our discontent not made glorious summer by this sun of York; and not all the clouds that lour’d upon our house are buried in the deep bosom of the ocean.
(c) Now is the winter of our discontent made glorious summer by this sun of York; and not all the clouds that lour’d upon our house are buried in the deep bosom of the ocean.
(d) If not all the clouds that lour’d upon our house are buried in the deep bosom of the ocean, then the winter of our discontent is not made glorious summer by this sun of York.

20.) Find the contrapositive of \( \sim (p \lor \sim q) \rightarrow r \).

21.) Symbolize the following argument and use a truth table to determine its validity:

Either Tom is wrong, or Mary is in trouble.
If Mary is not in trouble, then there’s no reason to worry.
There’s reason to worry.

\[ \therefore \text{Tom isn’t wrong.} \]

22.) Use an Euler diagram to determine the validity of the following argument:

All math majors are nerds.
Ruth is a math major.

\[ \therefore \text{Ruth is a nerd.} \]
23.) Use an Euler diagram to determine the validity of the following argument:

Some people who study do well.
Some people who are smart do well.

; Some people who study are smart.

24.) Suppose that $p$ is true but that both $q$ and $r$ are false. Which of the following must be true?

(a) $p \rightarrow (p \rightarrow r)$
(b) $p \land (q \lor r)$
(c) $(q \land r) \rightarrow p$
(d) $p \rightarrow (q \land r)$

25.) Which of the following is the negation of “Some cats have no tails”?

(a) Some cats have tails.
(b) All cats have no tails.
(c) No cats have tails.
(d) All cats have tails.