Hand-written exercises. You MAY NOT work alone on these. Do these alone first, then get with two or three other people to check each other’s answers. Agree among yourselves what the answers are BEFORE you write test programs to verify the answers. Then write and turn in one paper solution with all team members’ names on it. I do not want the test programs, just the team’s paper solution. I suggest using truth tables to analyze many of these.

1. Write a simple expression that is equivalent to !(!A && !B) without using !

2. If you are rich then you are automatically happy. If you are not rich then you may still be happy but only if you are both employed and healthy. Complete the following assignment statement using rich, employed and healthy (all bool variables) along with one or more logical operators.

   happy =

3. Which of the following are not equivalent to !(cold && rainy)? Hint: test your answers with a truth table.
   a. !(cold && rainy) || !rainy
   b. !cold || !rainy
   c. (!rainy || !cold) && (!cold || !rainy)
   d. !!(rainy || !cold)
   e. !cold && !rainy

4. Simplify (big && red) || red

5. Simplify (big || red) && big

6. Simplify !(big || red) && big

7. Assume that A, B and C are variables of type bool. Which of the following are not correct logical expressions in C++ (meaning they will not compile)?
   a. !(A) && (!B))
   b. !(!A || !!B)
   c. A ! && B && C
   d. !!A && !!B || !!C
   e. (!(!(!A))) && !B)

8. Simplify the following if-else statement by using logical operators. You will only need one if-else.
   Assume that A and B are variables of type bool.

   if (A)
     if (B)
       cout << "Fred";
     else
       cout << "Derf";
   else
     cout << "Derf";
9. Simplify the following if-else statement by using logical operators. You will only need one if-else.

```cpp
if (A)
    cout << "Man";
else if (B)
    cout << "Man";
else
    cout << "Van";
```

10. Specify the ranges of values of \( n \) (of type int) for which the following statement prints "Hello", "Goodbye" or nothing.

```cpp
if (n < 10)
    if (n > 5)
        cout << "Hello";
else
    cout <<"Goodbye";
```

11. Write the following if-else statement without using a "!" in the test condition:

```cpp
if (!narcissist && !psychopath)
    cout << "friend material";
else
    cout << "run away!";
```

12. Simplify the following nested if-else statement into a single if-else. Do not use a "!" in your answer.

```cpp
if (!famous)
    if (!rich)
        cout << "Unhappy";
    else
        cout << "Happy";
else
    cout << "Happy";
```

For each of the following pairs of expressions determine if they are "equivalent" or "not equivalent". Equivalent means they will produce the same columns of T/F values in truth tables. Test your answer by plugging in sample values. Careful: some of these are tricky.

13. \( a \leq b \)
    \( a < b \) && \( a == b \)

14. \( a \leq b \) || \( b \leq c \)
    \( a \leq c \)

15. \( (P || Q) \) && \( R \)
    \( (P && R) || (Q && R) \)

16. \( a == b \)
    !(a > b || b > a)
17. !(P && Q)  
   !P || !Q

18. P && (Q || !P)  
   P && Q

19. (!(P && Q))  
   !Q || P

20. Q || P || !Q  
   P || !P

21. !(big || round)  
   !big || !round

22. (big && round) || (big && !round)  
   big