Exercise 1: (H) SSA

Assuming all variables are live, transform the following program into SSA-form:

1. Perform the reaching definitions analysis and give the resulting sets for each node.

2. Transform the program by inserting necessary edges and parallel assignments $\psi$ (see pp. 614–615 of slides).

3. Perform renaming of the variables (Step 2, p. 623) and draw the resulting CFG.
Exercise 2: (H) Register allocation 

Consider the following basic block:

\[
\begin{align*}
t &= 0 \\
x &= t \\
y &= 1 \\
z &= x + y \\
x &= x + 1 \\
q &= x + y \\
y &= q + z \\
t &= t + 1 \\
x &= x + 1 \\
r &= y + t \\
res &= x + r
\end{align*}
\]

1. Compute the true liveness information for each program point. (The variable res is the only live variable at the end of this block.)

2. Construct the interference graph and the interval graph. (Note that you should split live ranges whenever possible, even when it is obvious that it will not improve register allocation.)

3. Provide an optimal coloring for the graph.

4. Give the optimal register allocation by replacing the program variables with registers \(R_0, R_1, R_2, \ldots\). At the end of execution of this block \(R_0\) should contain the value of res.