Friday 9/21 - Solving higher order.

Given a constant coefficient equation
\[ y'' + py' + qy = 0 \]
we can guess solutions of the form \( y = e^{rx} \).

We get the characteristic equation
\[ r^2 + pr + q = 0. \]
If there are two real roots \( r_1, r_2 \), we get a general solution \( y = c_1 e^{r_1x} + c_2 e^{r_2x} \).

If we have one root, the second solution is \( x e^{rx} \) instead (see "reduction of order").

There is a strong existence - uniqueness theorem, at least for linear equations.

3.2 A lot translates to higher order: superposition.
Solving with initial conditions, etc.

Ex. \( y'' + 2y'' - y' - 2y = 0 \) has characteristic polynomial \( r^2 + 2r - 1 - 2 = 0 \).
It factors as \((r-1)(r+1)(r+2)\)
\[ \rightarrow r = 1, -1, -2. \]
General solution is \( y = c_1 e^x + c_2 e^{-x} + c_3 e^{-2x} \).