3.3.2 two distinct real roots.
\[ 2r^2 - 3r = r(2r - 3) = 0 \]

3.3.6 a pair of complex roots.
\[ r^2 + 5r + 5 = 0 \]

3.3.14 two distinct real roots, and a pair of imaginary roots.
\[ r^4 + 3r^2 - 4 = (r^2 + 4)(r^2 - 1) = 0 \]

3.3.18
\[ r^4 - 16 = (r^2 + 4)(r^2 - 4) = 0 \]

3.3.22
\[ 9r^2 + 6r + 4 = (3r + 1)^2 + 3 = 0, \quad r = -\frac{1}{3} \pm \frac{1}{\sqrt{3}}i \]

3.3.25
\[ 3r^3 + 2r^2 = r^2(3r + 2) = 0, \]

we have \( r = 0 \) as a double root (corresponding to \( c_1 + c_2x \)), and another \( r = -2/3 \).
The general solution is
\[ y = c_1 + c_2x + c_3e^{-2x/3} \]

We differentiate twice to have \( y' \) and \( y'' \), plug in \( x = 0 \) in all of them (including \( y \)) and set them to the corresponding initial values. Then we have three linear equations to solve for \( c_1, c_2 \) and \( c_3 \).

3.3.28
\[ 2r^3 - r^2 - 5r - 2 = 0 \]

\( r = 2 \) is an obvious integral root. Use long division, we can factor it into another quadratic function multiplied to \( r - 2 \).

3.3.40 \( e^{2x} \) refers to \( r = 2 \), and the other two suggest \( r = \pm 2i \).
\[
\frac{dy}{dx} = \frac{dy}{dv} \frac{dx}{dv} = \frac{1}{x} \frac{dy}{dv},
\]

\[
\frac{d^2y}{dx^2} = \frac{d}{dx} \frac{dy}{dx} = \frac{d}{dx} \left( \frac{1}{x} \frac{dy}{dv} \right) = -\frac{1}{x^2} \frac{dy}{dv} + \frac{1}{x^2} \frac{d^2y}{dv^2}
\]

so the equation in \(v\) reads

\[
\frac{d^2y}{dv^2} + 9y = 0
\]

3.4.2 Use the formula \(T = 2\pi/\omega_0\), where \(\omega_0 = \sqrt{k/m}\).

3.4.5 Equation (19) on page 105 suggests that when an object is near the surface of the earth, the acceleration will be \(GM/r^2\), this should replace \(g\) in Equation (6) on page 187, so the circular frequency for a pendulum with length \(L\) located at a distance \(R\) form the earth center is

\[
\sqrt{\frac{GM}{R^2L}}
\]

Use the definition of period and its relation with frequency, we should be able to arrive at that formula.

3.4.9 Need to use \(kx_0 = mg\)

3.4.18 First determine how the system is damped. Compare \(c\) with \(c_{cr} = \sqrt{4mk}\), then use the appropriate solution.

3.4.24 In the critically damped case, we have a double root, the general solutions is

\[
x = (c_1 + c_2t)e^{-pt}
\]

3.4.27 Here we have two distinct real roots.

3.5.2 Try \(y_p = Ax + B\).

3.5.13 Try \(y_p = e^x(A\cos x + B\sin x)\).

3.5.23 Since \(\cos 2x\) and \(\sin 2x\) satisfy the homogeneous equation, we need to include \(x^2\cos 2x\) and \(x^2\sin 2x\).

3.5.28 Similar to 3.5.23, \(\sin 3x\) satisfies the homogeneous equation, we need to include terms with \(x^3\) multiplied.

3.5.34 First try \(y_p = x(A\cos x + B\sin x)\), determine \(A\) and \(B\), then combine with \(y_c = c_1\cos x + c_2\sin x\), choose \(c_1\) and \(c_2\) so that \(y_c + y_p\) satisfies the initial conditions.

3.5.38 \(\sin 3x\) does not satisfy the homogeneous equation so we can just try \(y_p = A\sin 3x + B\cos 3x\).