Problem Set 8

Differential Equations

Spring 2026

Welcome to the world of higher order differential equations. You can think of this as a natural expansion from the second order cases (characteristic equation, reduction of order, nonhomogeneous cases), just with more complicated computations and more variations...

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Veritas Forums: We endlessly desire more, but will we ever be fully satisfied? Join us as two leading civic voices (including Hahrie Han, SNF Agora) with different worldviews come together to discuss this question and its impact on both the self and society. RSVP: https://forms.gle/PXDhBKCqLvxZZAj5A.

Tip of the Week

The Life Design Lab:

The Recreation Center is home to 45+ club sports and various fitness programs. Check out their weight room, bouldering caves, the rock-climbing wall, and F45 circuit workouts. JHU students also have the opportunity to work with personal trainers. Visit the Rec Center website for more information.

1. (Undetermined Coefficients for Repeated Homogeneous Solution). Find the specific solution to the following differential equation:

$$y''(x) + 2y'(x) + 2y(x) = e^{-x} \sin x + \sin x.$$

2. (Euler's Equations). Find the full set of solutions for the following second order ODEs, given one solution:

$$x^2y'' + xy' - 4y = 0, \qquad y_1(x) = x^2.$$

Note: This type of second order ODE is called a "Euler's equation," which is in the form of:

$$x^2y'' + \alpha xy' + \beta y = 0,$$

and we will learn its characteristic equation and general solution in the later chapters.

3. (Variation of Parameters). Find the solution to the following differential equation:

$$y'' + 9y = \frac{1}{\sin 3x}.$$

4. (Euler's Formula and Roots of Polynomials). Find all complex roots for the following polynomial.

$$x^6 = 1.$$

Hint: Use Euler's formula as:

$$\exp(\mathrm{i}z) = \cos(z) + \mathrm{i}\sin(z),$$

and recall that $(e^{\mathrm{i}z})^r = e^{\mathrm{i}(rz)}$.