ME7100: Advanced Topics in Mathematical Tools
Assignment-3

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Due date: Monday, 13th February 2022, before the class begins. Make plots on a separate sheet of paper and include them along with your solutions.

Problem 1: Solve the following differential equation using the method of multiple scales for $\varepsilon > 0$:

$$\ddot{y} + y = \varepsilon \left(\dot{y} - \frac{1}{3}\dot{y}^3 \right), \qquad y(0) = 0, \quad \dot{y}(0) = \alpha.$$

Obtain the leading order solution for $y(t)$ and make a hand-sketch of the solution for some sample values of α. Comment on the nature of the solution as $t \to \infty$.

Problem 2: Obtain the solution of the damped oscillator using the method of multiple scales for $\varepsilon > 0$:

$$\ddot{y} + \dot{y} + \varepsilon(\dot{y})^3 = 0, \qquad y(0) = 1, \quad \dot{y}(0) = 0$$

Make a plot of the exact (numerical) solution of $y(t)$ vs t along with the solution obtained from perturbation techniques.