Analytical Mechanics II - PHYS 400/500 - *Spring 2019*

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www.aglatz.net/teaching/mechanicsII_S2019

Homework 3 HW

due *2019-02-14*, before class

Exams (tentatively)	midterm (tentatively): **Thursday, March 21, 2019**, *12:30-13:45* final: **Thursday, May 9, 2019**

Solve the following problems from the textbook: **4-1., 4-4., 4-9., 4-12. (for $\alpha = 3.5$)**

4-1. Refer to Example 4.1. If each of the springs must be stretched a distance d to attach the particle at the equilibrium position (i.e., in its equilibrium position, the particle is subject to two equal and oppositely directed forces of magnitude kd), then show that the potential in which the particle moves is approximately

$$U(x) \cong (kd/l)x^2 + [k(l - d)/4l^3]x^4$$

4-4. Lord Rayleigh used the equation

$$\ddot{x} - (a - b\dot{x}^2)\dot{x} + \omega_0^2 x = 0$$

in his discussion of nonlinear effects in acoustic phenomena.* Show that differentiating this equation with respect to time and making the substitution $y = y_0\sqrt{3b/a}\dot{x}$ results in van der Pol's equation:

$$\ddot{y} - \frac{a}{y_0^2}(y_0^2 - y^2)\dot{y} + \omega_0^2 y = 0$$

*J. W. S. Rayleigh, *Phil. Mag.* 15 (April 1883); see also Ra94, Section 68a.

4-9. Investigate the motion of an undamped particle subject to a force of the form

$$F(x) = \begin{cases} -kx, & |x| < a \\ -(k + \delta)x + \delta a, & |x| > a \end{cases}$$

where k and δ are positive constants.

4-12. Let the value of α in the logistic equation, Equation 4.46, be equal to 3.5. Make a map like that in Figure 4-21 when $x_1 = 0.4$. Make the plot for three other values of x_1 for which $0 < x_1 < 1$.

You can solve 4-24. for extra credit.