Problem Set 2 (due Sep 2, 2018)

1. **(Feynman diagrams, Anharmonic oscillator)** Consider the following lagrangian

$$\mathcal{L} = \frac{1}{2}m(\dot{x}^2 - \omega^2 x^2) - g_3 \frac{1}{3!} x^3 - g_4 \frac{1}{4!} x^4 \ . \quad (1)$$

   (a) Calculate the correction to the ground state energy to the lowest non-trivial order in g_3 using time-independent perturbation theory

   (b) Calculate the correction to the ground state energy to the lowest non-trivial order in g_4 using time-independent perturbation theory

   (c) Calculate the correction to the first excited state energy to the lowest non-trivial order in g_3 using time-independent perturbation theory

   (d) Calculate the correction to the first excited state energy to the lowest non-trivial order in g_4 using time-independent perturbation theory

   (e) Draw the Feynman diagram corresponding to the calculation of the correction to the ground state energy to the lowest non-trivial order in g_3. Evaluate the diagram and compare the result to the previous calculation using time-independent perturbation theory

   (f) Draw the Feynman diagram corresponding to the calculation of the correction to the ground state energy to the lowest non-trivial order in g_4. Evaluate the diagram and compare the result to the previous calculation using time-independent perturbation theory

   (g) Draw the Feynman diagram corresponding to the calculation of the correction to the first excited state energy to the lowest non-trivial order in g_3. Evaluate the diagram and compare the result to the previous calculation using time-independent perturbation theory

   (h) Draw the Feynman diagram corresponding to the calculation of the correction to the first excited state energy to the lowest non-trivial order in g_4. Evaluate the diagram and compare the result to the previous calculation using time-independent perturbation theory