Waves
Homework Set 2

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Question:

Consider the oscillation of a pendulum: The diagram illustrates that the potential energy of the pendulum bob is given by $U(\theta) = mgL(1 - \cos\theta)$, where $U(\theta) = 0$ at the bottom of the swing. The kinetic energy is $K = {}^1/_2 mv^2$, where $v = L\dot{\theta}$.

a. Use the full energy method to derive the exact governing differential equation $\ddot{\theta} = -\dfrac{g}{L}\sin\theta$. Show all steps of the necessary logic/math.

b. In the potential energy function $U(\theta) = mgL(1 - \cos\theta)$, make a Maclaurin expansion of $\cos\theta$ out to second order in θ so that the total energy function has one term quadratic in $\dot{\theta}$ and one term quadratic in θ. Then write the new approximate expression for the total energy.

c. Use the full energy method to derive the approximate governing differential equation $\ddot{\theta} = -\dfrac{g}{L}\theta$. As you know, that approximate governing differential equation has exact simple harmonic motion as its general solution.

Question:

Consider the funciton $f(x) = (a+x)^2$, where a is a constant, where $x < a$ and where x and a have the same units.

Make a binomial expansion of $f(x) = (a + x)^2$

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