Homework Assignment #2
(due: Wednesday, September 6, 9 am)

1. **Work-KE Theorem:** Taylor 4.4 (2P)
   
   Hint: In (b) slowly means $\ddot{r} = 0$.

2. **Two Interacting Particles:** Taylor 4.49 & 4.50 (2P)

3. **Many Particles: SiO$_2$** (2P)
   
   In class we have determined the force $\vec{F}_i$ on a particle $i$ for a system with Lennard-Jones interactions. These forces are the core of the molecular dynamics simulations I run and analyze in my research. Another system which I study is SiO$_2$, which is the main component of window glass. During the last ten years the following BKS Potential [Phys. Rev. Lett. 64, 1955 (1990)] has been shown to be a good model for real SiO$_2$:

   \[
   U_{ij}(r_{ij}) = \frac{q_i q_j e^2}{r_{ij}} + A_{ij} \exp\left(-B_{ij} r_{ij}\right) - \frac{C_{ij}}{r_{ij}^6}
   \]

   where $r_{ij} = |\vec{r}_i - \vec{r}_j|$ and $q_i, A_{ij}, B_{ij}$, and $C_{ij}$ are constants. Similar to the calculation in class, determine the force $F_i$ on particle $i$ due to all other particles $j = 1, \ldots, N$. $^1$

4. **Solid at Low Temperature:** Taylor problem (5.19) (3P)

   Hints:
   
   (1) You want to show that $U = U_0 + k' r^2$
   
   (2) Use that $x$ and $y$ are small. You will have to use $\sqrt{1 + z} \approx 1 + \frac{z}{2} - \frac{z^2}{8}$.
   
   Keep all terms up to order $x^2$ and $y^2$.

5. **Driven Damped Oscillator:** (3P)

   4a. Reproduce Fig. (5.15) of Example (5.3) (pages 185/186)
   
   4b. Taylor problem (5.36)

6. **Fourier Series:** Taylor problems (5.47) and (5.48) (3P)

   (5.47) is the proof for orthogonality of the basis vectors and (5.48) proves what one might guess for how to get the components, i.e. coefficients $a_n$ and $b_n$.

7. **Fourier Series for Driven Oscillator:** Taylor 5.52 (3P)

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$^1$To tell the whole truth, since the Coulomb force is long ranged, the actual calculation of this term is in practice more complicated.