- [1.] Sidebottom Problem 1.1
- [2.] Sidebottom Problem 1.4
- [3.] Sidebottom Problem 1.7
- [4.] Sidebottom Problem 1.9

Each of problems 5-7 will require a paragraph or thereabouts of writing.

[5.] What is "graphene" and what is its structure? What is a "carbon nanotube" and how does it relate to graphene? What do "armchair," "zigzag," and "chiral" mean in referring to a nanotube?

[6.] The "family" of high temperature (cuprate) superconductors contains many compounds. $La_{2-x}Sr_xCuO_4$ is one example. The "parent" compound, La_2CuO_4 is an antiferromagnetic insulator. What is the lattice structure of La_2CuO_4 ? What is a "perovskite"?

[7.] Another "family" of superconductors are the iron pnictides. What is the structure of the "1111" material LaOFeAs?

The problems below are *numeric*. I will be available in the computer lab, room 106, Wednesday 10:00 am - noon to help with these problems, or with general background on writing C programs, compiling them, etc.

[8.] We often encounter transcendental equations in physics. For example, in the quantum problem of the energy levels of a particle in a finite square well, you need to solve,

$$\tan z = \sqrt{(z_0/z)^2 - 1}$$

Write a bisection program (do *not* use some canned root-finding software) and find the solution to this equation for $z_0 = 2.5$. Looking at the figure 2.18 in Griffiths will help you pick a good set of initial values to bracket the solution. (For this problem you can just treat z_0 as number. However, for completeness, let me remind you of the connection of z_0 to the physics: $z_0 = (a/\hbar)\sqrt{2mV_0}$ where 2a is the well width, V_0 is the well depth, and m is the particle mass. For $z_0 = 2.5$ it turns out there is just a single bound state.)

[9.] Given a normalized vector \vec{v} with components v_n , $n = 1, 2, \dots N$, the participation ratio

$$\mathcal{P} = \left(\sum_n v_n^4\right)^{-1}$$

provides an estimate of the number of components of \vec{v} which are of significant size. When we study lattice vibrations and the effects of defects, it will be useful for us to compute \mathcal{P} . Write a C program to compute \mathcal{P} , for vectors \vec{v} with components

$$v_n = A \exp\left(-\frac{(n-N/2)^2}{\xi^2}\right)$$

Here ξ is a free parameter. You need to normalize \vec{v} , that is, choose A so that $\sum_n v_n^2 = 1$. By looking at the form of v_n what would you guess should be a reasonable result for \mathcal{P} ? That is, how would you expect \mathcal{P} to depend on ξ ? Does your program conform to this expectation?