# Department of Physics
# University of Maryland, College Park

## Assignment 10, Physics 374 — Due Thursday, May 6, 2010

Note: In solving math problems, you have to provide the details of intermediate steps. Without those steps, you cannot get full credit.

**Problem 1** In calculating the Green's function for the Schrodinger equation in 3D, we encounter the following 3D integral,

$$I(\vec{r}) = \frac{1}{(2\pi)^3}\int d^3\vec{k}e^{i\vec{k}\cdot\vec{r}}e^{i\hbar\vec{k}^2t/2m} \tag{1}$$

Evaluate the above integral as a product of three one-dimensional integrals.

**Problem 2**

Consider the one-dimensional Green's function equation for $G$,

$$\frac{\partial G(t,t')}{\partial t} + \beta G(t,t') = \delta(t-t') \tag{2}$$

Consider solving $G$ with two different boundary conditions. And show that the difference of the two Green's functions is a solution of the homogenous equation. [Hint: consider G vanishes before $t = t'$ and after $t = t'$ separately.]

**Problem 3**

Consider the Helmholtz equation in 2D

$$\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + k^2\psi = 0 \tag{3}$$

in a rectangular box with length $L_x$ in the x-direction and $L_y$ in the y-direction. Therefore, $x$ and $y$ coordinates are limited to $(0, L_x)$ and $(0, L_y)$, respectively. If $\psi$ vanishes at the boundary of the box, calculate the normal modes for the system.

**Problem 4**

Consider the normal modes of a drum in Sec. 20.2. Show that the different normal modes are orthogonal to each other. Using the trick that I have shown you in the lecture.

**Problem 5**

Derive a completeness relation for the normal modes on a drum by expanding a function $f(r,\theta)$ in terms of the normal modes.