Chapter 3b – Problems

(1) **2-D problem!** Two infinitely long grounded metal plates, at y=0 and y=a, are connected at x=0 and x =b, by metal strips maintained at V=0 and V=V respectively. Find the potential inside the resulting rectangular pipe.

(2) 3-D problem! A cube is grounded on the surface (length a), except for one surface that has a potential V. What is the potential inside the cube?

(3) More 3-D! If the potential on a hollow sphere is given by:

$$V(R.\vartheta) = cos\,\vartheta\,\left(1 - \frac{5}{2}\sin^2\vartheta\right)$$

a. Find the first 4 Legendre polynomials.
b. Find the $V(R,\vartheta)$ in terms of Legendre polynomials.
c. Find the functional form of the potential.

(4) **This is start to get hard:** A specified charge density is glue over the surface of a hollow spherical shell of radius R.

$$\sigma(\vartheta) = k\cos\vartheta = kP_1(\cos\vartheta)$$

a. Using the separation of variables method, find the potential inside the sphere. Remember to apply boundary conditions at r=0.
b. Using the separation of variables method, find the potential inside the sphere. Remember to apply boundary conditions at r=∞.
c. (Tricky) What's the boundary condition at the surface?
d. What's the final solution for V?
e. What's the E Field?

(5)

3.10 Suppose $V_1(\mathbf{r})$ and $V_2(\mathbf{r})$ are linearly independent functions which *both* solve Laplace's equation, $\nabla^2 V = 0$

Does $aV_1(\mathbf{r})+bV_2(\mathbf{r})$ also solve it (with a and b constants)?

A) Yes. The Laplacian is a linear operator
B) No. The *uniqueness theorem* says this scenario is impossible, there are never two independent solutions!
C) It is a definite yes or no, but the *reasons* given above just aren't right!
D) It depends...

(6)

What is the value of

$$\int_0^{2\pi} \sin(2x)\sin(3x)dx \quad ?$$

A) Zero

B) π

C) 2π

D) other

E) I need resources to do an integral like this!

Concept Question

Name: ____

What is the solution to the following differential equation?

$$\frac{1}{X(x)}\frac{\partial^2}{\partial x^2}X(x) = k$$

One-Minute Paper

Please answer the following questions about today's lecture:

1) What was the most important thing you learned today?

2) What is the one thing that remains most unclear at the conclusion of today's lecture?

3) Any additional comments?