9/22/2004. **Due:** Wednesday, Sept. 29, 2004 (in class).

# Physics 301/571: Electromagnetic Theory I

**Read: Griffiths** chapter 1.5-1.6, 2.1-2.2

"**G**" refers to Griffiths' book.
Problems with stars are not for credit and will NOT be graded.

# Homework 3

## Exercise 1 (G 1.43, 1.44)

Evaluate the following integrals:

a) $\int_2^6 (3x^2 - 2x - 1)\delta(x - 3)\, dx$
b) $\int_{-\infty}^{+\infty} \ln(x + 3)\delta(x + 2)\, dx$
c) $\int_0^2 (x^2 + 3x + 2)\delta(1 - 2x)\, dx$
d) $\int_{-\infty}^{a} \delta(b - x)\, dx$

## Exercise 2 (G 1.47 partial)

Evaluate the following integrals:

a) $\int_{\text{all space}} (r^2 + \vec{r} \cdot \vec{a} + a^2)\delta^3(\vec{r} - \vec{a})\, d\tau$, where $\vec{a}$ is a fixed vector and $a$ is its magnitude.

b) $\int_{\mathcal{V}} |\vec{r} - \vec{b}|^2 \delta^3(5\vec{r})\, d\tau$, where $\mathcal{V}$ is a cube of side 2, centered on the origin, and $\vec{b} = 4\hat{\mathbf{y}} + 3\hat{\mathbf{z}}$.

## *Exercise 3 (G 1.48 partial)

Evaluate the integral

$$J = \int_{\mathcal{V}} e^{-r} \left( \vec{\nabla} \cdot \frac{\hat{\mathbf{r}}}{r^2} \right) d\tau,$$

where the integral is taken over some volume $\mathcal{V}$. Consider both cases: a) origin does not belong to $\mathcal{V}$ and b) origin belongs to $\mathcal{V}$.

## Exercise 4

Is it possible to write the field

$$\vec{F} = (x + yz)\,\hat{\mathbf{x}} - 3y^2 z\,\hat{\mathbf{y}} + (3yz^2 + x - z)\,\hat{\mathbf{z}}$$

as a curl of some vector potential $\vec{A}$?

## *Exercise 5

Find the vector potential $\vec{A}$ of the field

$$\vec{F} = 2(y + xz)\,\hat{\mathbf{x}} + 2x\,\hat{\mathbf{y}} + (1 - z^2)\,\hat{\mathbf{z}}.$$

## Exercise 6 (G 2.5)

Find the electric field a distance $z$ above the center of a circular loop of radius $r$, which carries a uniform line charge $\lambda$.

## Exercise 7 (G 2.6)

Find the electric field at a distance $z$ above the center of a flat circular disk of radius $R$, which carries a uniform surface charge $\sigma$. What does your formula give in the limit $R \to \infty$? Also check the case $z \gg R$.

## Exercise 8 (G 2.9)

Suppose the electric field in some region is found to be $\vec{E} = kr^3\,\hat{\mathbf{r}}$, in spherical coordinates ($k$ is some constant).

a) Find the charge density $\rho$.

b) Find the total charge contained in a sphere of radius $R$, centered at the origin. (Do it two different ways.)