Instructions-

This is a closed book exam. No memory aids of any kind, electronic or otherwise, may be used. You have fifty (50) minutes to complete it.

1. Before starting work, check to make sure that your test is complete. You should have 6 numbered pages.

Exam Grading Policy-

The exam is worth a total of 100 points, each problem has its point value marked. The first three problems are mostly conceptual in nature and require little or no computation. Nevertheless, work or explanations need to be provided for credit. **Partial credit will be awarded for incomplete solutions.** Give all answers in terms of given quantities (note that constants such as \( \pi \) or \( \varepsilon_0 \) may also appear in any solution). Work in a logical, clear, and legible manner. Work each problem on the paper provided – extra paper will be provided if you should need it.

Possibly useful relations:

\[
\vec{F} = q_0 \vec{E}, \quad \vec{a} = (q / m) \vec{E}, \quad \Phi = \oint \vec{E} \cdot d\vec{A}, \quad E \propto \frac{1}{4\pi \varepsilon_0} \frac{\vec{P}}{r^3}, \quad \vec{E} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \cdots
\]

\[
E = \frac{\eta}{\varepsilon_0}, \quad E = \frac{\eta}{2\varepsilon_0}, \quad \vec{E} = \frac{1}{4\pi \varepsilon_0} \int \frac{dq}{r^2}, \quad E = \Delta V / d, \quad V = \sum_{i=1}^{N} V_i(r) = \frac{1}{4\pi \varepsilon_0} \sum_{i=1}^{N} \frac{q_i}{r_i}, \quad U = qV
\]

\[
\Delta U = q \Delta V, \quad \Delta V = -\frac{\text{Work}}{q}, \quad W = \int \vec{F} \cdot d\vec{s}, \quad KE = \frac{1}{2}mv^2, \quad I = \frac{dQ}{dt}, \quad J = \frac{I}{A}, \quad J = \sigma E
\]

\[
\rho = \frac{1}{\sigma}, \quad \sum I_{in} = \sum I_{out}, \quad V_{sphere} = \frac{4}{3} \pi R^3, \quad V_{cylinder} = \pi R^2 L, \quad A_{sphere} = 4\pi R^2
\]

\[
A_{cylinder} = 2\pi RL, \quad \vec{E} \cdot d\vec{A} = E \cos \theta dA, \quad \vec{E} \cdot d\vec{s} = E \cos \theta ds
\]

\[
\int \frac{dx}{a + bx} = \frac{1}{b} \ln |a + bx|, \quad \int \frac{dx}{x} = \ln x, \quad \frac{d}{d\theta} \tan \theta = \frac{d\theta}{\cos^2 \theta}, \quad \int \sin \theta d\theta = -\cos \theta, \quad \int \cos \theta d\theta = \sin \theta
\]

\[
\int_{0}^{\infty} \frac{xdx}{\left(x^2 + y^2\right)^{\frac{3}{2}}} = \frac{1}{y}, \quad \int_{0}^{\infty} \frac{dx}{\left(x^2 + y^2\right)^{\frac{1}{2}}} = \frac{1}{y^2}
\]

Here’s a joke: **Where does Dracula usually go for his lunch?**

answer on page 6