Problem 1 (25 points):

There is a transmission line whose characteristic impedance is unknown. However, its length is known to be two wavelengths. If the load impedance is 100 Ohms as shown in the figure below, find out the input impedance $Z_{in}$.

![Diagram of a transmission line with a load impedance of 100 Ohms and a length of 2 wavelengths.]

Problem 2 (25 points):

A perfect conductor sphere of radius 5 m is placed in a material of relative permittivity 3, and centered at the origin. The electric field on the surface of the sphere is $\vec{E} = \frac{2}{\varepsilon_0} \vec{a}_r$ V/m. Find the total charges carried by the conductor sphere.
Problem 3 (50 points):

Assume a line current of 5 A is placed along z axis from z = 0 to z = 1 m, and completely enclosed in a perfectly conducting cylindrical cavity filled with a lossy material, as shown in Fig. 1. If along the line current, the electric field is known to be $\vec{E} = -\hat{z}(2 + j) \text{ V/m}$, determine the time average power dissipated in the cavity.

![Diagram showing a cylindrical cavity with a line current and electric field](image)

Fig. 1: A line current completely enclosed in a PEC cavity filled with a lossy material.