Fields and Waves I

Exam 2 Review

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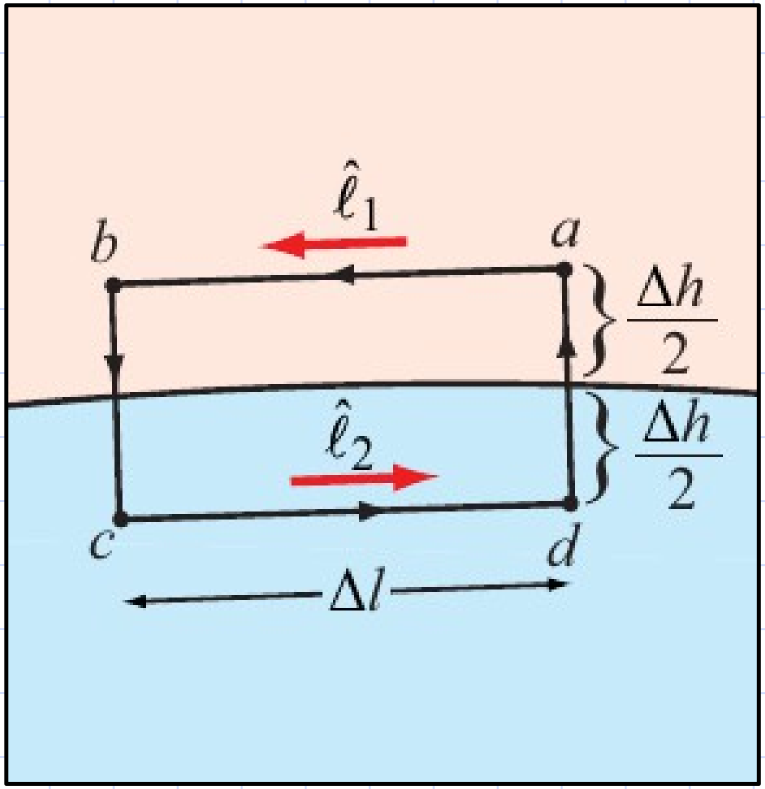
Boundary Conditions

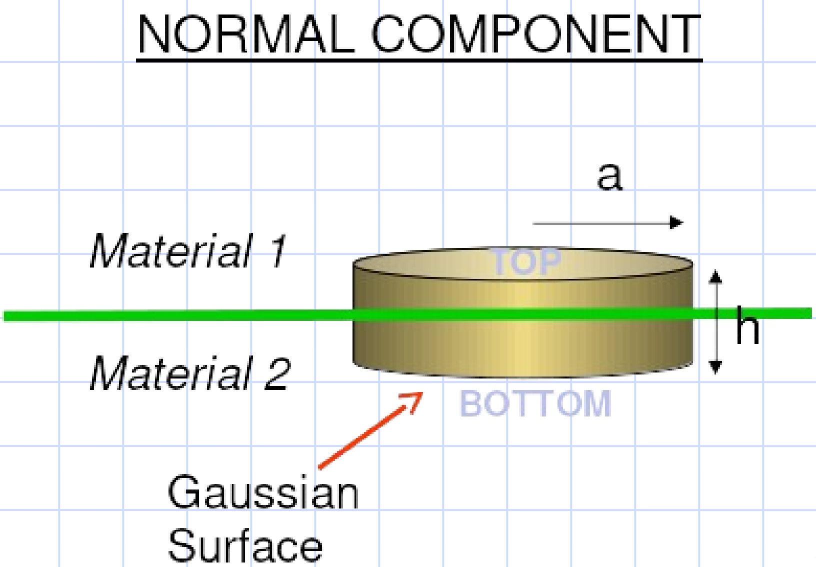


Ulaby

$$\vec{E}_{1t} = \vec{E}_{2t}$$

- So component of the E-field that is tangent to a media boundary is continuous across it.
- What about normal to the boundary?

Boundary Conditions



$$\oint D \bullet ds = Q_{enclosed}$$

Take h << a **(a thin disc)**

$$Q_{enclosed} = \rho_s \cdot A$$

$$\oint D \bullet ds = \int_{TOP} D \bullet ds + \int_{BOTTOM} D \bullet ds$$

$$= (D_{1n} - D_{2n}) \cdot A$$

$$\therefore D_{1n} - D_{2n} = \rho_s$$

Dielectrics + Boundary Conditions

1.) An electric field of 4 V/m strikes a dielectric of relative permittivity 10 at an angle of 45 degrees. Determine the magnitude of the E-field inside the material as well as its angle relative to the boundary.

2.) Replace the dielectric with a conducting material. What is its surface charge density where the electric field touches it?

Dielectrics + Boundary Conditions

Dielectrics + Boundary Conditions

Laplace and Poisson Equations

- Laplace's Equation: $$\nabla^2 V = 0$$

- Poisson's Equation $$\nabla^2 V = -\frac{\rho}{\varepsilon}$$

$$\nabla^2 = \begin{bmatrix} \frac{\partial V}{\partial x} & \frac{\partial V}{\partial y} & \frac{\partial V}{\partial z} \end{bmatrix} \bullet \begin{bmatrix} \frac{\partial}{\partial x} \\ \frac{\partial}{\partial y} \\ \frac{\partial}{\partial z} \end{bmatrix} = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2}$$

(in cartesian coordinates)

Laplace and Poisson Equations

- A dielectric sphere with 10cm radius, relative permittivity 5, and a bound charge of 1 C/m3 is grounded at its center. Use Laplace and Poisson's Equations to find the voltage at all r.

Laplace and Poisson Equations

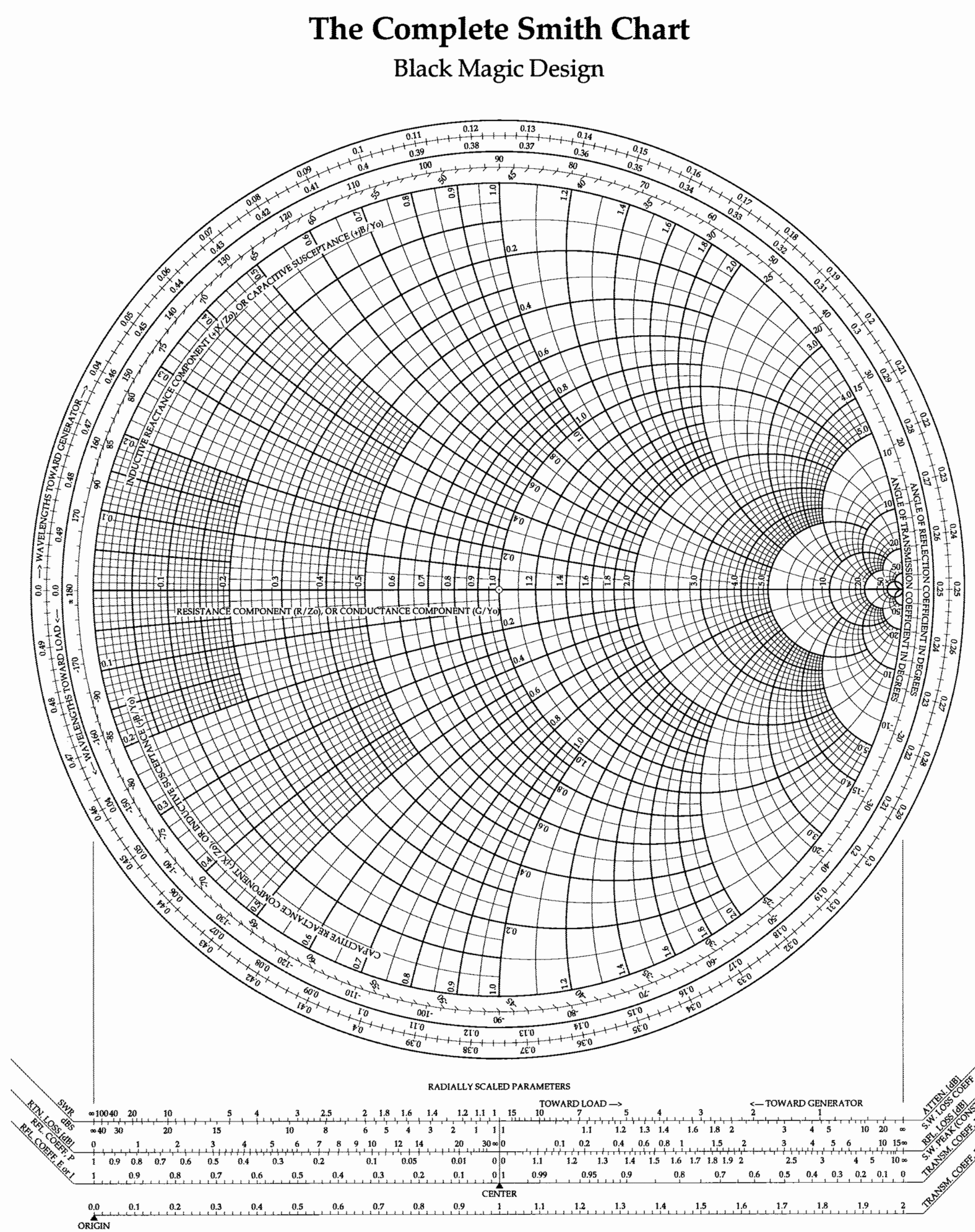
Laplace and Poisson Equations

Smith Charts

1.) Suppose the input impedance of a 0.2 wavelength transmission line is 4 ohms. Find the load impedance.

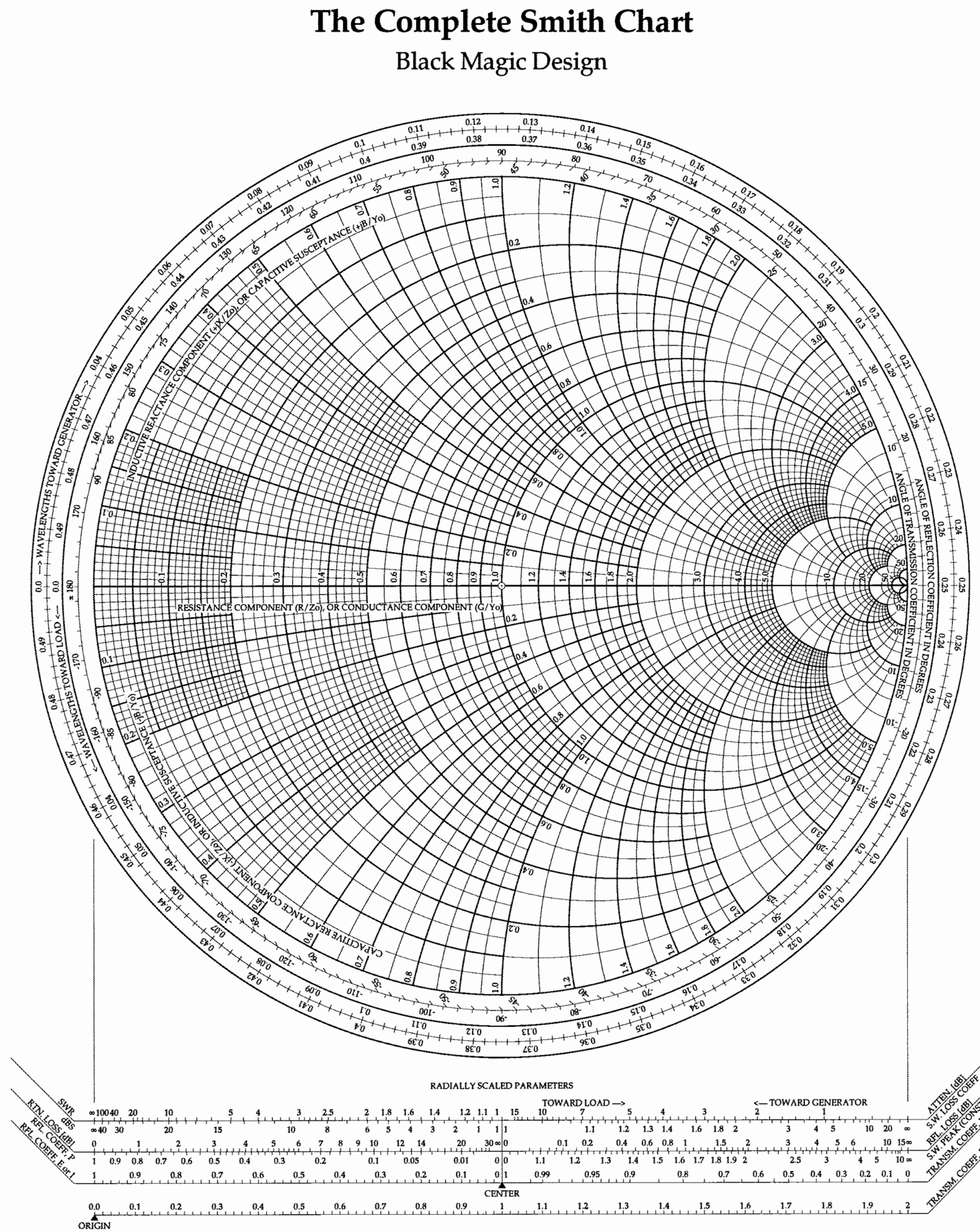
2.) You have a length of transmission line with a load at the end. Its input admittance is 1+0.7j. You wish to match it to the line's characteristic impedance. What length of open-circuit stub should be added in parallel at this point to match the line?

Smith Charts



Field

Smith Charts



Field

Field Math

Differential Surfaces and Volumes

How do you describe the shapes of all the ds surfaces in the following coordinate systems?

- Cartesian coordinates: https://mathinsight.org/cartesian_coordinates

- Cylindrical coordinates: https://mathinsight.org/cylindrical_coordinates

- Spherical coordinates: https://mathinsight.org/spherical_coordinates