Problem 1

1. Consider a static charge density \( \rho(x, y, z) = 6\delta(z) + \rho_s\delta(z-10) \) C/m\(^3\) in a given region, where the displacement field is \( \mathbf{D} = \hat{\mathbf{e}}z \delta(z) + \hat{\mathbf{e}}2 \) C/m\(^2\) for \( 0 < z < 10 \) m and \( D_z = 2 \) C/m\(^2\) for \( z > 10 \) m. Furthermore, field \( \mathbf{D} \) is uniform in each of regions \( z < 0, 0 < z < 10 \) m, and \( z > 10 \) m.

   a) Determine \( \rho_s \),

   b) Determine \( \mathbf{D} \) for the region \( z > 10 \) m

   c) Determine \( \mathbf{D} \) for the region \( z < 0 \).

Problem 2

2. Write a program that simulates the response (voltage at near and far ends) of a lossless transmission line terminated with linear resistive loads. Test your program using the example shown below. Use \( Z_0 = 75 \) \( \Omega \), \( \tau = 2.37 \) ns, \( Z_1 = 50 \) \( \Omega \), \( Z_2 = 1 \) K\( \Omega \). Optimize your code to minimize run time. Show plots of the pulse response at the near and far ends of the line. Give a listing of your program.

\[ \begin{array}{c}
Z_1 \quad Z_0 \quad \tau \\
V_g \\
\downarrow \\
\downarrow
\end{array} \]

The pulse characteristics for \( V_g(t) \) are as shown in the figure below, with

- time delay: \( t_d = 1 \) ns
- rise time: \( t_r = 1 \) ns
- fall time: \( t_f = 1 \) ns
- pulse width: \( t_w = 20 \) ns
- pulse amplitude: \( V_{\text{max}} = 4 \) volts
Amplitude

\[ V_{\text{max}} \]

\[ t_d \quad t_r \quad t_w \quad t_f' \]

time