

**Problem 7.21** Based on wave attenuation and reflection measurements conducted at 1 MHz, it was determined that the intrinsic impedance of a certain medium is  $28.1 \angle 45^\circ (\Omega)$  and the skin depth is 2 m. Determine the following:

- (a) The conductivity of the material.
- (b) The wavelength in the medium.
- (c) The phase velocity.

**Solution:**

- (a) Since the phase angle of  $\eta_c$  is  $45^\circ$ , the material is a good conductor. Hence,

$$\eta_c = (1 + j) \frac{\alpha}{\sigma} = 28.1 e^{j45^\circ} = 28.1 \cos 45^\circ + j28.1 \sin 45^\circ,$$

or

$$\frac{\alpha}{\sigma} = 28.1 \cos 45^\circ = 19.87.$$

Since  $\alpha = 1/\delta_s = 1/2 = 0.5$  Np/m,

$$\sigma = \frac{\alpha}{19.87} = \frac{0.5}{19.87} = 2.52 \times 10^{-2} \text{ S/m}.$$

- (b) Since  $\alpha = \beta$  for a good conductor, and  $\alpha = 0.5$ , it follows that  $\beta = 0.5$ . Therefore,

$$\lambda = \frac{2\pi}{\beta} = \frac{2\pi}{0.5} = 4\pi = 12.57 \text{ m}.$$

- (c)  $u_p = f\lambda = 10^6 \times 12.57 = 1.26 \times 10^7$  m/s.
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