377.

Problem 31.47 (RHK)

A coaxial cable used in a transmission line responds as a "distributed" capacitance to the circuit feeding it. We have to calculate the capacitance of 1.00 km *for a cable having an inner radius of* 0.110 mm *and an outer radius of* 0.58 mm. *We may assume that the space between the conductors is filled with polystyrene.*

Solution:

The capacitance of a coaxial cable of length L, inner radius a and outer radius b, and filled with material having dielectric constant κ is

$$C = \frac{2\pi\varepsilon_0 \kappa L}{\ln\left(\frac{b}{a}\right)}.$$

Dielectric constant of polystyrene is

$$\kappa = 2.6 .$$

Therefore, the capacitance of the 1.00 km coaxial cable with dimensions

$b = 0.588$ mm,

and

$a = 0.110$ mm

will be

$$C = \frac{2\pi \times 8.85 \times 10^{-12} \times 2.6 \times 10^{3}}{\ln\left(\frac{0.588}{0.110}\right)}\ \text{F} = 86.2 \times 10^{-9}\ \text{F} = 86.2\ \text{nF}.$$