General Sir John Kotelawala Defence University

ET3212 Microwave Engineering
Transmission Lines - Exercises

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Exercise 1

A transmission line has a per unit length inductance of 400 nH/m and per unit length capacitance of 70 pF/m. Calculate the characteristic impedance of the transmission line.

Exercise 2

The per unit length values of inductance, capacitance, resistance and dielectric conductance of a transmission line at 100 MHz are given by 190 nH, 75 pF, 2.6 mΩ and 67 S respectively. Find

1. The characteristic impedance
2. The propagation coefficient at 100 MHz
3. The attenuation of the transmission line in decibels per meter.

Exercise 3

Find the phase velocity of the transmission lines of Exercise 1 and Exercise 2.

Exercise 4

A power amplifier with an output of 200 mW is connected to a 50 Ω transmission line which is subsequently connected to an antenna with an impedance of 58+j10 Ω. If the output impedance of the power amplifier is 48 Ω calculate

1. the reflection coefficient between the power amplifier and transmission line
2. the reflection coefficient between the transmission line and antenna and
3. the power radiated from the antenna.

Exercise 5

The antenna of a low power microwave communication module reflects 6.3% of the power back in to the transmission line. Calculate the VSWR between the transmission line and antenna.

Exercise 6

An antenna datasheet mentions the maximum VSWR as 1.5 dB. Find the maximum possible value of the reflection coefficient ρ_0.

Exercise 7

A coaxial microwave transmission line operates at a frequency of 2.4 GHz. It has core and shielding radii of 0.5 mm and 2.3 mm respectively. It has a characteristic impedance of $50\ \Omega$.

1. Find the required relative permittivity (ϵ_r) of the dielectric medium of the coaxial cable.
2. Calculate the per unit length inductance and capacitance of the coaxial cable.
3. Verify the feasibility of the cable parameters.

Exercise 8

The substrate of a printed circuit board has a relative permittivity (ε_r) of 4.2 and thickness of 1.5 mm. The one sided copper layer has a thickness of 0.5 mm. Find the characteristic impedance of a slotline with a width of 1 mm and spacing of 2.5 mm.

Exercise 9

A printed circuit board has a relative permittivity (ε_r) of 4.3 and thickness of 1.4 mm which excludes the 0.6 mm copper layer on either side. Calculate the characteristic impedance of the resulting microstrip transmission line if the width is

1. a narrow 0.8 mm
2. a wide 3.4 mm

Exercise 10

The printed circuit board of a microwave circuit has a thickness (h) of 2.5 mm, copper thickness (t) of 0.7 mm and relative permittivity (ϵ_r) of 4.2. The circuit requires a microstrip transmission line to connect a power amplifier output to a printed antenna. The required impedance of the transmission line is 170 Ω. Using a suitable approximation find the required width (w) of the microstrip.