Chapter 19: Radiated Emissions and Susceptibility

19.1 The ignition system of a car is interfering with the AM radio in the car. Is this conducted or radiated interference? Explain.

19.2 A vacuum cleaner is interfering with a TV set. Is this conducted or radiated interference? Explain.

19.3 In reference to the discussion in this chapter concerning emissions from a twin-lead line, determine a better *approximation* for the total electric field than

$$E_{\theta totals} \approx M_s \frac{e^{-j\beta_o r}}{r}\left(I_{1s}e^{-j\beta_o\Delta} + I_{2s}e^{j\beta_o\Delta}\right)F(\theta)$$

19.4 In reference to the discussion in this chapter concerning emissions from a twin-lead line, determine a better *approximation* for the total electric field in the far field from a pair of differential-mode currents than

$$E_{\theta totals} \approx \frac{d\eta_o \pi I_{Ds} l_{th}}{\lambda_o^2}\frac{e^{-j\beta_o r}}{r}\sin^2\theta\sin\phi$$

19.5 In reference to the discussion in this chapter concerning emissions from a twin-lead line, determine a better *approximation* for the total electric field in the far field from a pair of common-mode currents than

$$E_{\theta totals} \approx j\frac{\eta_o\beta_o}{2\pi} l_{th}\frac{e^{-j\beta_o r}}{r} I_{Cs}\sin\theta$$

19.6 Using superposition, determine the expression for the short-circuit current for the Hertzian dipole using the susceptibility model developed for the twin-lead line. However, unlike the discussion in this chapter, assume that the “load” is on the right side of the circuit model instead of the left side. Then, simplify the expression for lower frequencies. Which term in the approximate expression is the correction term?

19.7 Referring to Figure 1, verify that for electrically-short lines that the voltage across the source resistor is also independent of the capacitance and inductance of the line:

$$V_s = -\frac{R_s}{R_{Ld}+R_s}V_{Is} + \frac{R_{Ld}}{R_s+R_{Ld}}R_s I_{Is}$$

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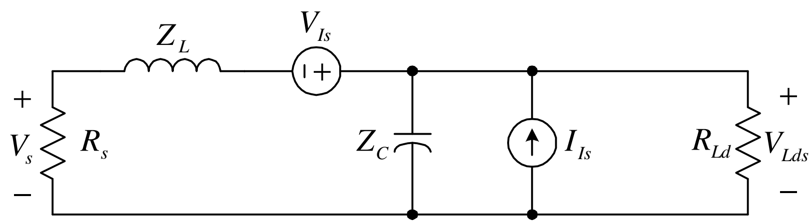

Figure 1

Use the same assumptions as given in this chapter.

19.8 Starting with the electrically-long susceptibility model provided in this chapter, determine the current in the source and load terminations for an electrically-short lossless twin-lead line when the source and load impedance are matched (i.e., equal) to the characteristic impedance of the twin-lead line. Then, as in this chapter, assume that the electric field components are described by

$$E_{zs}^{inc}(0,z) \approx E_{zo}^{inc},\ E_{zs}^{inc}(d,z) \approx E_{zo}^{inc}(1-j\beta d)$$
$$E_{xs}^{inc}(x,0) \approx E_{xo}^{inc},\ E_{xs}^{inc}(x,l_{th}) \approx E_{xo}^{inc}$$

and further simplify the expressions to obtain a first-order approximation for each of the currents. Are these currents zero? Why are these currents not zero considering that the source and load are matched?

19.9 For each of the given Poynting vectors and polarization angles, determine e_x, e_y, e_z, β_x, β_y, and β_z,. Then, substitute these results into

$$\vec{E}_{is} = E_{os}\left(e_x\hat{a}_x + e_y\hat{a}_y + e_z\hat{a}_z\right)e^{-j\beta_x x}e^{-j\beta_y y}e^{-j\beta_z z}$$

and sketch both the Poynting vector and electric field.

a) $\theta_E = 180^\circ,\ \theta_P = 45^\circ,\ \phi_P = 90^\circ$

b) $\theta_E = 45^\circ,\ \theta_P = 90^\circ,\ \phi_P = 0^\circ$

c) $\theta_E = 0^\circ,\ \theta_P = 135^\circ,\ \phi_P = -45^\circ$

d) $\theta_E = 0^\circ,\ \theta_P = 135^\circ,\ \phi_P = 45^\circ$

19.10 Imagine that a sinusoidal current with an amplitude of I and a frequency of f is injected into the "output" leads of a tightly wound coil with N turns. Each turn has a radius of a, and the total axial length of the coil is L. The relative permeability of the core is one. Using the reciprocity theorem, determine the induced voltage across a single open-circuited loop passing through the window of this current probe. State all assumptions. [Heller]

19.11 Determine the expression for the output voltage for a resistively loaded current probe if the test wire carrying a sinusoidal current is centered in the window of the probe and the probe consists of a <u>circular</u> cross-section, air-core N-turn coil.

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When is this probe acting like a 1:*N* ideal transformer? Determine the output if the load consists of a series *RC* integrator circuit.

19.12. A current probe has a transfer impedance of 0 dB ±2 dB over the frequency range 50 kHz to 200 MHz. What is the minimum and maximum voltage output over this frequency range for a 1 mA input current? State all assumptions.

19.13 A current probe has a transfer impedance greater than 0 dB over a limited frequency range. Is this possible? Explain.

19.14 A current probe consists of 50 turns on an air-core toroid. The toroid has an inner radius of 1.6 cm, an outer radius is 2.5 cm, and a height of 1.4 cm. Over what frequency range is this current probe acting like an ideal current transformer? If the coil is wrapped on a ferrite with a relative permeability of about 125, will the self inductance increase by about 125? Will the mutual inductance increase by about 125?

19.15 What simple experiment can be performed to determine whether the parasitic capacitance between a current probe and the circuit under test is significant? [Smith, '93]

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