

Antenna Theory

Thevenin Equivalent Circuit Problem

Problem 2.68

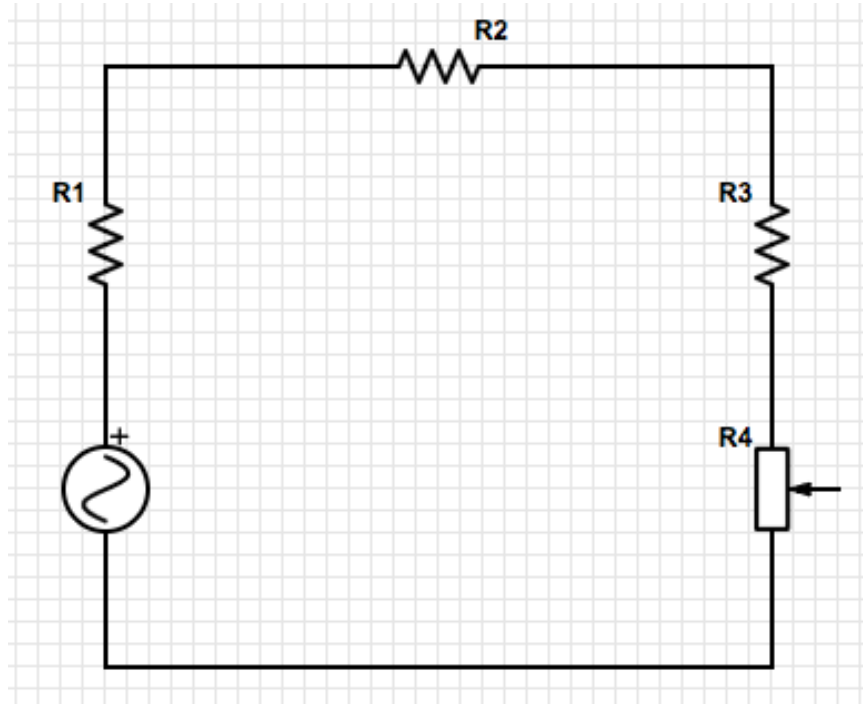


Figure1

Problem:

A 1-m long dipole antenna is driven by a 150 MHz source having a source resistance of 50 ohms and a voltage of 100 V. If the ohmic resistance of the antennas is given by $R_L = 0.625$ ohms, find the:

- (a) Current going into the antenna (I_{ant});
- (b) Power dissipated by the antenna
- (c) Power radiated by the antenna;
- (d) Radiation efficiency of the antenna

Symbols:

- (a) I_{ant} : Antenna Current
- (b) $R_2 = R_s = 50 \text{ ohms}$: Source Resistance
- (c) $R_2 = R_{Loss} = R_L = 0.625 \text{ ohms}$: Loss Resistance of the Antenna
- (d) $R_3 = R_r = 73 \text{ ohms}$: Radiation Resistance of the Antenna
- (e) $R_4 = X_A = j42.5 \text{ ohms}$: Antenna Reactance at terminal a-b (up-down)
- (f) e_{cd} : Radiation efficiency of the Antenna

Background:

Note that only R_r part contributes to the radiation. In short, this impedance will guide how much power will be radiated. R_L will guide how much power will be lost as heat. R_s is the

internal resistance in the source. In addition, the current on this equivalent circuit and the desired resistance/impedance will be used to calculate the corresponding power.

Solved:

- (a) The current on this circuit can be simply calculated by the division of voltage and the total impedance in the circuit.

$$I_{ant} = \frac{V_s}{R_s + R_L + R_r + jX_A} = \frac{100V}{50 + 0.625 + 73 + j42.5} = 0.723 - j0.249 = 0.765e^{-j19}$$

where the angle in degree.

- (b) It should be carefully noted that the source resistance is not part of the antenna. Thus, the power dissipated by the antenna can be expressed:

$$P_{diss} = P_{Loss} = \frac{1}{2} |I_{ant}|^2 R_{Loss} = 0.183 \text{ W} = 183 \text{ mW}$$

- (c) The power delivered to the Antenna can be computed by:

$$P_r = \frac{1}{2} |I_{ant}|^2 R_r$$

Note that R_r is a passive component in the circuit, which is a loss. In transmitting mode, this lost power will be used in radiation process. Antenna in receiving mode will take this power, ideally all this amount of power.

- (d) The radiation efficiency can be computed by:

$$e_{cd} = \frac{R_r}{R_r + R_{Loss}} = \frac{73}{73 + 0.625} = 99.15\%$$

Reference:

[1] Antenna Theory: Analysis and Design, 4th Edition by Constantine A. Balanis