HW #3

All are at the end of chapter 2.

1. Problem 2.37 in 7/E and 6/E (Problem 2.25 in Answer Sheet. See also Problem 2.29 in 7/E & 6/E, which is Problem 2.19 in Answer Sheet, for essentially the same question presented in a different way).

Problem 2.25 A lossless transmission line is terminated in a short circuit. How long (in wavelengths) should the line be in order for it to appear as an open circuit at its input terminals?

Problem 2.19 Show that the input impedance of a quarter-wavelength long lossless line terminated in a short circuit appears as an open circuit.

2. Problem 2.36 in 7/E and 6/E (i.e. Problem 2.24 in Answer Sheet)

Problem 2.24 At an operating frequency of 300 MHz, it is desired to use a section of a lossless 50-Ω transmission line terminated in a short circuit to construct an equivalent load with reactance $X = 40$ Ω. If the phase velocity of the line is $0.75c$, what is the shortest possible line length that would exhibit the desired reactance at its input?

3. Problem 2.38 in 7/E and 6/E (i.e. Problem 2.26 in Answer Sheet)

Problem 2.26 The input impedance of a 31-cm-long lossless transmission line of unknown characteristic impedance was measured at 1 MHz. With the line terminated in a short circuit, the measurement yielded an input impedance equivalent to an inductor with inductance of 0.064 μH, and when the line was open circuited, the measurement yielded an input impedance equivalent to a capacitor with capacitance of 40 pF. Find Z_0 of the line, the phase velocity, and the relative permittivity of the insulating material.

4. Problem 2.39 in 7/E and 6/E (i.e. Problem 2.27 in Answer Sheet and 5/E).

Problem 2.27 A 75-Ω resistive load is preceded by a $\lambda/4$ section of a 50-Ω lossless line, which itself is preceded by another $\lambda/4$ section of a 100-Ω line. What is the input impedance?

5. Problem 2.40 in 7/E and 6/E (i.e. Problem 2.28 in Answer Sheet and 5/E).

Problem 2.28 A 100-MHz FM broadcast station uses a 300-Ω transmission line between the transmitter and a tower-mounted half-wave dipole antenna. The antenna impedance is 73 Ω. You are asked to design a quarter-wave transformer to match the antenna to the line.

(a) Determine the electrical length and characteristic impedance of the quarter-wave section.

(b) If the quarter-wave section is a two-wire line with $d = 2.5$ cm, and the spacing between the wires is made of polystyrene with $\varepsilon_r = 2.6$, determine the physical length of the quarter-wave section and the radius of the two wire conductors.

6. Problem 2.42 in 7/E and 6/E (i.e. Problem 2.31 in Answer Sheet and 5/E).

Problem 2.31 A generator with $\widetilde{V}_g = 300$ V and $Z_g = 50\ \Omega$ is connected to a load $Z_L = 75\ \Omega$ through a 50-Ω lossless line of length $l = 0.15\lambda$.

(a) Compute Z_{in}, the input impedance of the line at the generator end.

(b) Compute $\widetilde{I}_i$ and $\widetilde{V}_i$.

(c) Compute the time-average power delivered to the line, $P_{in} = \frac{1}{2}\mathfrak{Re}[\widetilde{V}_i\widetilde{I}_i^*]$.

(d) Compute $\widetilde{V}_L$, $\widetilde{I}_L$, and the time-average power delivered to the load, $P_L = \frac{1}{2}\mathfrak{Re}[\widetilde{V}_L\widetilde{I}_L^*]$. How does P_{in} compare to P_L? Explain.

(e) Compute the time average power delivered by the generator, P_g, and the time average power dissipated in Z_g. Is conservation of power satisfied?

7. Problem 2.43 in 7/E and 6/E (i.e. Problem 2.32 in Answer Sheet and 5/E). Hint: work backwards from the loads, and you'll find Z_{in}. Then it becomes a super simple circuit problem.

Problem 2.32 If the two-antenna configuration shown in Fig. 2-41 (P2.32) is connected to a generator with $\widetilde{V}_g = 250$ V and $Z_g = 50\ \Omega$, how much average power is delivered to each antenna?