Problem 1.

You measure the *Insertion Loss* (IL) of a filter with a signal generator with 50 Ω output impedance and a spectrum analyzer with 1 MΩ input impedance. You have used this setup without impedance matching network and you realize this fact a few days later. What can you do in order to correct the results?

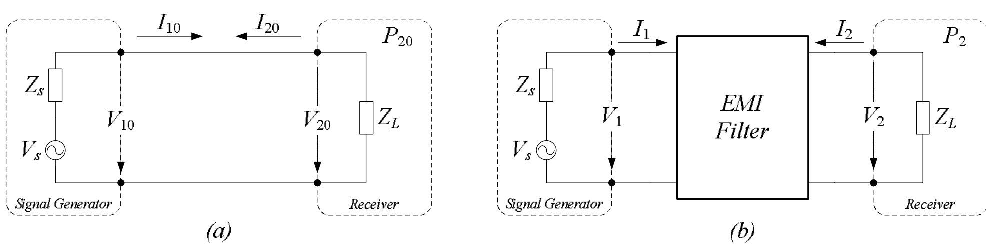
Problem 2.

Consider the setup for measuring insertion loss $IL = 10 \cdot \lg\left(\frac{P_{20}}{P_2}\right)$ as shown in figure below. The test item is a noise suppression capacitor with reactance *X*. The impedances of the signal generator and measuring equipment are resistive and equal to 50 Ω. Calculate and draw the insertion loss as a function of frequency in the following cases:

a) *X* is an ideal capacitor *C* = 10 μF.

b) *X* is an ideal inductor *L* = 1 μH.

c) *X* is a real capacitor with *C* = 10 μF and series inductance *L* = 1 μH.



Problem 3

A single-stage *LC*-filter, shown in Figure 1, is used to suppress *common mode* (CM) noise from a power supply. Filter component values are: C_X = 47 nF, C_Y = 2.2 nF and *L* = 0.13 mH. Calculate the CM *IL* of the filter at 150 kHz and 1 MHz. Assume three different measurement resistances: 50 / 50 Ω, 0.1 / 100 Ω, and 100 / 0.1 Ω.

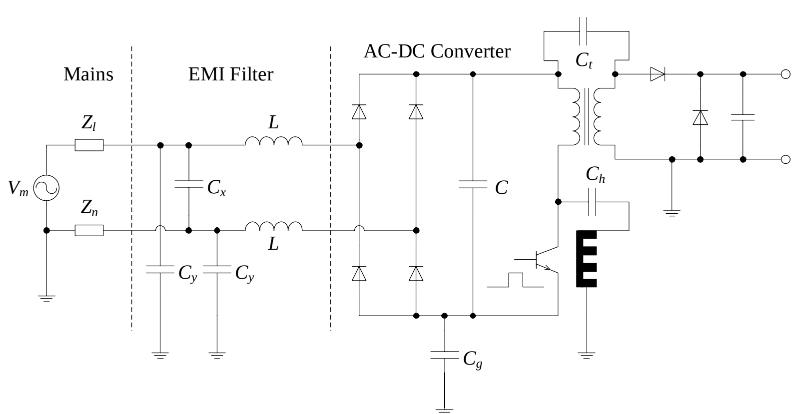


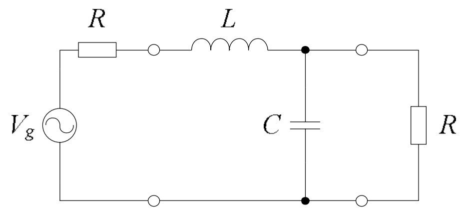
Fig. 1. A switch-mode power supply (SMPS) with input EMI filter.

Problem 4

This continues the previous problem: For the SMPS in Figure 1, draw the *differential mode* (DM) noise equivalent circuit of the filter and calculate the value of *DM insertion loss* (IL_{DM}) of that filter at 150 kHz and 1 MHz. Use the same values as in Problem 3 and compare the results with the previous ones for CM noise.

Problem 5

Design an *LC*-filter, which provides insertion loss of 50 dB at 150 kHz. The allowed 50 Hz voltage drop is 5 V when the current is 15 A and R = 5 W. Sketch the diagram of insertion loss versus frequency.



Problem 6

This problem highlights the case of mismatch due to low source impedance. Consider a single stage LC-filter (1 mH / 250 nF). The source impedance Z_g is assumed to be zero. The worst case *IL* is achieved when load impedance Z_L is purely inductive ($R_L = 0$, $L_L \neq 0$). What is the value of the load inductance L_L to have the worst case at 150 kHz? What is the value of *IL* at 150 kHz, if a 50 Ω resistive load is assumed?

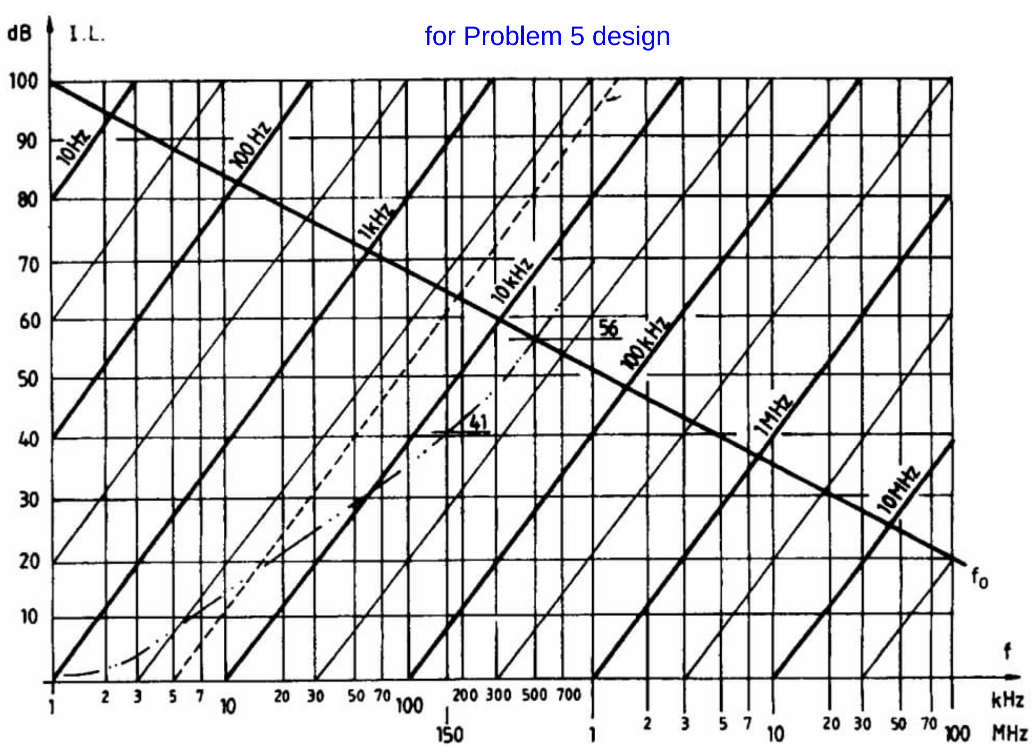


Fig. 9. Figure 9.3 from the textbook. Butterworth response, i.e. the *IL* for ideally damped LC-configuration with resistive source and load impedances.