Physics 623 – Problem Set 1

Due Tues. Sept. 9 in class

1. **T-pad attenuator.** Calculate $R_1$, $R_2$, and $R_3$ in the circuit of Figure 1 so that the voltage across $R_L$ would be one tenth the value it would have if the network in the box were omitted and such that the resistance seen by the source and the load are the same as they would have been without the network.

2. Consider the circuit shown in Figure 2. What conditions must be met to balance the bridge (null the response of the meter) at all frequencies?

3. **Radiofrequency Single Electron Transistor (rf SET).** Devise an $LC$ network to match a 25 kΩ source to a transmission line impedance of 50 Ω at a frequency of 1 GHz. (This is the trick behind the rf SET: a way to read out the SET at high speed, despite the fact that the characteristic impedance of this device is in the range of tens of kΩ).

4. **LCR tank circuit.** Consider the circuit of Figure 3. Transmission across the LCR resonant circuit is maximum at a frequency $\omega_0 \approx 1/\sqrt{LC}$. Solve for $P_{out}/P_{in}$ (the ratio of power transmitted to spectrum analyzer to power delivered by the generator) on resonance in terms of $R$ and $R_i$. Work in the high-$Q$ limit, and assume $C \gg C_c$, $1/\omega_0 C_c \gg R$.

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![Figure 1: Circuit for Problem 1.](image-url)
Figure 2: Circuit for Problem 2.

Figure 3: Circuit for Problem 4.