EE101: Electrical Sciences

Tutorial-8, Oct. 27, 2017

Pre-Tutorial Problem

A resistor R_{AB} has the following characteristics.

$$R_{AB} = \begin{cases} \infty & \text{for } V_{AB} < 0.7 \\ 0 & \text{for } V_{AB} \geq 0.7 \end{cases}$$

(i) Plot the I-V characteristics (X-axis is V_{AB} and Y-axis is I_{AB}) of this resistor.

(ii) Draw the transfer characteristics of the following circuits.

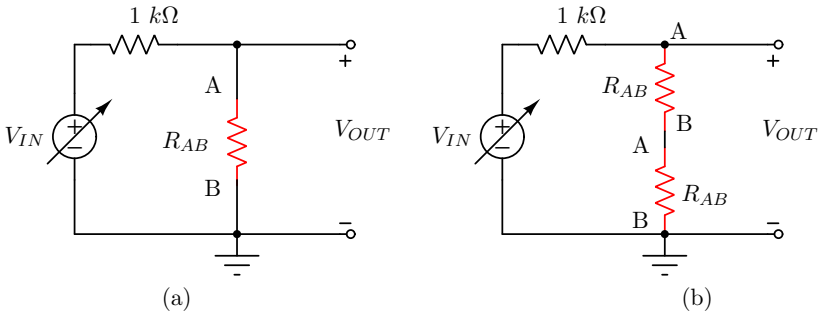


Figure 1: Circuits for pre-tutorial problem

(iii) Can you think of an application of this circuit (assuming the resistor R_{AB} really exists)?

Tutorial Problems

1. Block diagram of an audio system is shown below.

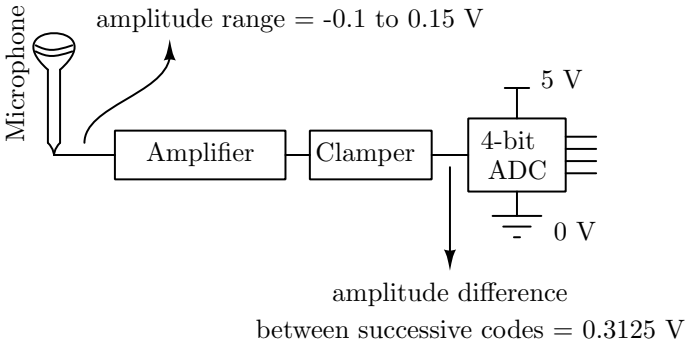


Figure 2: Block diagram of an audio system

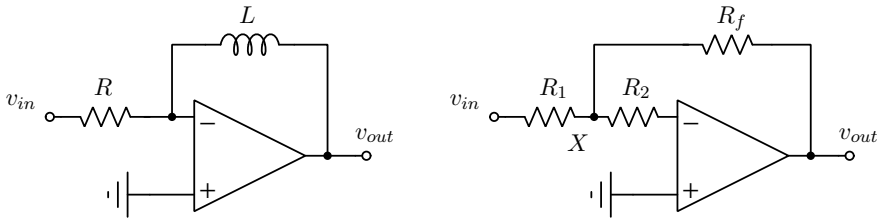
Under no load condition (or infinite load impedance), the amplitude of the voltage signal generated by the microphone is in the range of -0.1 V to 0.15 V. This signal needs to be processed by an ADC such that the full-range of ADC codes (0000 for 0 V and 1111 for 5 V) are used.

(i) What is gain of the amplifier required?

(ii) What is the DC-offset that need to be provided by the clamper circuit?

(iii) The microphone can't drive any (low) impedance (i.e., it can't output any current). Realize the above amplifier using an ideal opamp and resistors. What is your choice of configuration and why?

2. Assuming an ideal opamp, derive the output voltage expressions.



(a) (b)

Figure 3: Opamp based circuits

3. Three identical coils, each having a reactance of 20 Ω and a resistance of 20 Ω are connected (a) in star, (b) in delta across 440 V, 3-phase line. Calculate for each method of connection, the line current and the readings on each of the two wattmeters connected to measure the power.

4. For the magnetic circuit of Fig. 4, N = 400 turns. Mean core length $l_c = 50$ cm. Air gap length $l_g = 1$ mm. Cross-sectional area $A_c = A_g = 15$ cm^2. Relative permeability of core $\mu_r = 3000$. $i = 10$ A. Find (a) Flux and Flux density in the air gap. (b) Inductance of the coil.

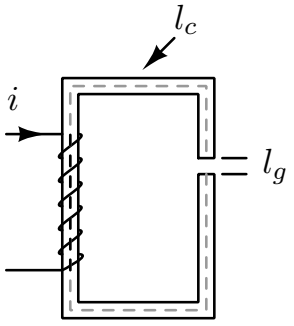


Figure 4: