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EPE 2165—Analog Electronics

HOMEWORK #1—Signals and amplifiers

Question:	1	2	3	4	5	6	Total
Points:	10	10	20	20	15	25	100
Score:							

Issued on: *May 18, 2022*
Due on: May 26, 2022

1. Ohm's law relates V, I, and R for a resistor. For each of the situations following, find the missing item:
   (a) ($2\frac{1}{2}$ points) $R = 1\,\text{k}\Omega, V = 5\,\text{V}$
   (b) ($2\frac{1}{2}$ points) $V = 5\,\text{V}, I = 1\,\text{mA}$
   (c) ($2\frac{1}{2}$ points) $R = 10\,\text{k}\Omega, I = 0.1\,\text{mA}$
   (d) ($2\frac{1}{2}$ points) $R = 100\,\Omega, V = 1\,\text{V}$
2. FIG 1 (a) shows a two-resistor voltage divider. Its function is to generate a voltage V_o (smaller than the power-supply voltage V_{DD}) at its output node X. The circuit looking back at node X is equivalent to that shown in FIG 1 (b). Observe that this is the Thevenin equivalent of the voltage-divider circuit.

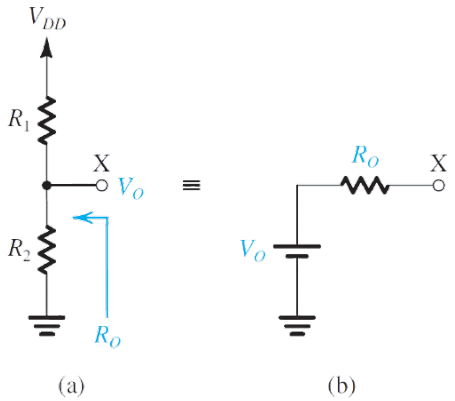

FIGURE 1. Two-resistor voltage divider.

   (a) (5 points) Find expressions for V_o for $V_{DD} = 5V, R_1 = R_2 = 1k$
   (b) (5 points) Find expressions for Ro for $V_{DD} = 5V, R_1 = R_2 = 1k$
3. (20 points) An amplifier has the following RMS[1] characteristics: $v_I = 100mv, i_I = 100\mu A, v_o = 10V, R_L = 100\Omega$. Find its the voltage, current, and power gains (A_v ,A_i , and A_p, respectively) both as ratios and in dB
4. Suppose you are part of team that needs to design a voltage amplifier which will be driven from a signal source v_s with an amplitude of $v_s = 5mV$ peak amplitude and a source resistance of $R_s = 10k\Omega$. Assuming that the amplifer must supply a peak output of $v_o = 2V$ across a $R_L = 1k\Omega$ load $\cdots$
   (a) (5 points) What is the required voltage gain from the source to the load?
   (b) (5 points) If the peak current available from the source is $0.1\mu A$, what is the smallest input resistance allowed?

[1] Remember the root-mean-square (RMS) value of a voltage V_a is equal to$V_{RMS} = \frac{V_a}{\sqrt{2}}$

(c) (5 points) For the design with the value of R_i obtained in question (b) above, find the overall current gain and power gain.

(d) (5 points) If the amplifier power supply limits the peak value of the output open-circuit voltage to 3 V, what is the largest output resistance allowed?

5. A spectrum analyzer is used to measure a square a square-wave signal. The spectrum analyzer is a frequency-selective voltmeter and show its spectrum to contain adjacent components (spectrallines) at 98 kHz and 126 kHz of amplitudes 63 mV and49 mV, respectively.

   (a) (5 points) For this signal, what would direct measurement of the fundamental show its frequency and amplitude to be?

   (b) (5 points) What is the RMS value of the fundamental?

   (c) (5 points) What are the peak-to-peak amplitude and period of the originating square wave?

6. An amplifier operating from $\pm 3V$ supplies provides a $2.2V$ peak sine wave across a $100\,\Omega$ load when provided with a 0.2 V peak input from which 1.0mA peak is drawn. The average current in each supply is measured to be 20 mA.

   (a) (5 points) Find the voltage gain of the amplifier

   (b) (5 points) Find the current gain of the amplifier

   (c) (5 points) Find the power gain of the amplifier and express it in decibels

   (d) (10 points) Find the supply power, amplifier dissipation, and amplifier efficiency.