

EE4445 Quiz 3

April 12, 2010

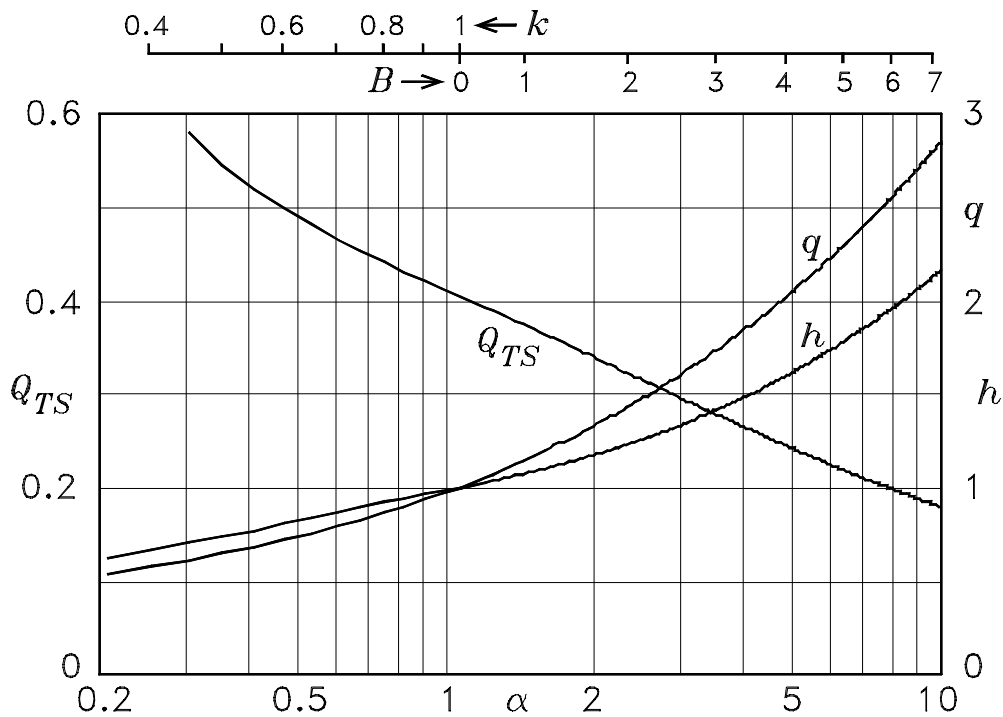
Professor Leach

Name _____

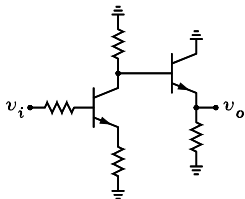
Instructions. Print your name in the space above and at the top of all other pages in your quiz. Express all numerical answers as a decimal number. When appropriate, draw a box around answers.

Honor Code: *I have neither given nor received help on this quiz.* Initials _____

1. A closed-box loudspeaker system is to be designed for a total quality factor $Q_{TC} = 1.5$ and an internal volume of $V_{AB} = 0.8 \text{ ft}^3 = 22.61 (10001 = 1 \text{ m}^3)$. It can be assumed that $M_{AC} = M_{AS}$. The box is to be filled and the mechanical quality factor is estimated to be $Q_{MC} = 3$.
 - (a) What is the required value of the electrical quality factor Q_{EC} ?
 - (b) The lower -3 dB cutoff frequency is specified to be $f_\ell = 48 \text{ Hz}$. Calculate the required value of the closed-box resonance frequency f_C .
 - (c) The compliance ratio is specified to be $\alpha = 7$. What is the required driver volume compliance V_{AS} ?
 - (d) What is the required value of the driver resonance frequency f_S ?
 - (e) What is the required driver electrical quality factor Q_{ES} ?
2. *For full credit on this problem, draw the pertinent horizontal and/or vertical lines on the design chart and circle the pertinent points.* A driver with an advertised diameter of 8 in ($a = 8 \text{ cm}$) is to be designed for the fundamental resonance frequency $f_S = 33 \text{ Hz}$. It is to be used in a vented-box enclosure with a lower -3 dB cutoff frequency $f_\ell = 43 \text{ Hz}$. The $Q_L = 7$ design chart is to be used for the system design. The driver is estimated to have a mechanical quality factor $Q_{MS} = 3$.
 - (a) If the internal volume of the enclosure is to be $V_{AB} = 0.6 \text{ ft}^3 = 171 (10001 = 1 \text{ m}^3)$, what is the required volume compliance V_{AS} of the driver in ft^3 ?
 - (b) What is the required Helmholtz resonance frequency f_B of the system?
 - (c) What is the vented-box “alignment” of the system?
 - (d) What are the required total quality factor Q_{TS} and electrical quality factor Q_{ES} of the driver?



3. For credit on this problem, you must draw the phasor diagrams and clearly label each phasor. A 4th-order active high-pass filter crossover network is used on a midrange in a 3-way loud-speaker system. The crossover frequency between the woofer and the midrange is to be at the frequency for which the phase lead of the midrange transfer function is 45° . If the phase of the woofer transfer function is 0° , what are the three lowest order active low-pass crossover networks that can be used with the woofer? Assume that both the woofer and the midrange are connected in electrical phase to the crossover networks.
4. A stereo amplifier is rated at an average sine-wave power $P_{ave} = 75 \text{ W}$ per channel into an 8Ω load.
- The plus and minus power supply voltages must be greater than the peak output voltage. What is this voltage?
 - Draw the block diagram of a negative feedback amplifier and use it to derive the gain formula $A/(1 + bA)$.
 - The figure shows the signal circuit of a two-BJT amplifier, i.e. the circuit with the power supply voltages zeroed and the ac coupling capacitors shorted. If a single resistor is connected from the v_o node to an input node of the first BJT, which node must it be connected to for the feedback to be negative?



Problem 1

$$Q_{TC} := 1.5 \quad V_{AB} := 0.8 \quad Q_{MC} := 3 \quad f_L := 48 \quad \alpha := 7$$

$$\text{Part (a)} \quad Q_{EC} := \frac{Q_{MC} \cdot Q_{TC}}{Q_{MC} - Q_{TC}} \quad Q_{EC} = 3$$

$$\text{Part (b)} \quad x := \frac{1}{2 \cdot Q_{TC}^2} - 1 \quad f_C := \frac{f_L}{\sqrt{x + \sqrt{x^2 + 1}}} \quad f_C = 68.636$$

$$\text{Part (c)} \quad V_{AS} := \alpha \cdot V_{AB} \quad V_{AS} = 5.6$$

$$\text{Part (d)} \quad f_S := \frac{f_C}{\sqrt{1 + \alpha}} \quad f_S = 24.266$$

$$\text{Part (e)} \quad Q_{ES} := \frac{Q_{EC}}{\sqrt{1 + \alpha}} \quad Q_{ES} = 1.061$$

Problem 2

$$a := 8 \quad f_L := 43 \quad Q_L := 7 \quad Q_{MS} := 3 \quad V_{AB} := 0.6 \quad f_S := 33$$

$$\text{Part (a)} \quad q := \frac{f_L}{f_S} \quad q = 1.303 \quad \alpha := 1.89 \quad h := 1.16 \quad Q_{TS} := 0.345$$

$$V_{AS} := \alpha \cdot V_{AB} \quad V_{AS} = 1.134$$

$$\text{Part (b)} \quad f_B := h \cdot f_S \quad f_B = 38.28$$

$$\text{Part (c)} \quad Q_{B3}$$

$$\text{Part (d)} \quad Q_{TS} = 0.345 \quad Q_{ES} := \frac{Q_{MS} \cdot Q_{TS}}{Q_{MS} - Q_{TS}} \quad Q_{ES} = 0.39$$

Problem 3

The midrange is at +225 degrees.

The woofer can have a 1st, 2nd, or 3rd order crossover network.

Problem 4

$$P_{ave} := 75 \quad R_L := 8$$

$$\text{Part (a)} \quad V_p := \sqrt{P_{ave} \cdot 2 \cdot R_L} \quad V_p = 34.641$$

Part (c) From the output to the base.