Overview

In this unit your students should:

- learn about the block diagram for an audio system
- understand the function of each block
- be able to draw the circuit diagram of each block
- understand the need for impedance matching between sub-systems

This should not require more than 4 hours of class time.

Hour	Suggested Activity
1	Launch them straight into the **Loading signal sources** practical. This should give them an idea of the practical importance of impedance matching as well as introducing the idea of log scales for graphs. As they finish, they could start the **Sound-to-light converter** practical. They will have a chance to finish it in a later session. Ask them to study **8.1** from the text book and answer questions 1 and 2 of the **Audio Systems** exercises before the next session.
2	Discuss their answers to questions 1 and 2 of the **Audio Systems** exercises. Get them to work through the rest of the questions of the **Audio Systems** exercises. As they finish, let them continue with the **Light-to-sound converter** practical. Ask them to answer question 1 from page 134 of the text book before the next session.
3	Launch students straight into the **Power amplifier** practical. Make sure that they don't dismantle their sound-to-light converter as they will need it for step 5. Avoid unsafe wires trailing between benches. Ask them to answer question 3 from page 134 of the text book before the next session.
4	Students should use this session to work through any unanswered questions on pages 134 and 135 of the text book. Questions 2, 4 and 5 require the idea of input and output impedance, a concept that many students find it difficult to grasp. Ask them to study **8.2** from the text book before the next session.

Model Answers

1 (a) microphone→preamp→volume control→voltage amp→power amp→loudspeaker

(b) The microphone produes a very small a.c. signal with frequency between 20 Hz and 20 kHz. The preamplifier increase the amplitude of this signal by perhaps +10. The volume control allows a variable fraction between 1 and 0 of the preamplifier output through to the voltage amplifier. This has a large negative (for stability) gain (perhaps -100), so its output is masured in volts rathee than millivolts. The power amplifier passes a copy of this signal on to the loudspeaker, boosting the current so that the loudspeaker can produce lots of sound.

2 (a) 68 kΩ

(b) R_{total} = 6.8 kΩ + 68 kΩ = 75 kΩ

$I = V/R = 25\times10^{-3} / 75\times10^{3} = 3.33\times10^{-7}$ A

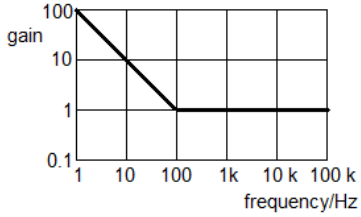
$V_{mic} = IR = 3.33\times10^{-7} \times 68\times10^{3} = 2.3\times10^{-1}$ V or 23 mV

percentage signal loss = (2 / 25) × 100 = 8 ≈ 10%

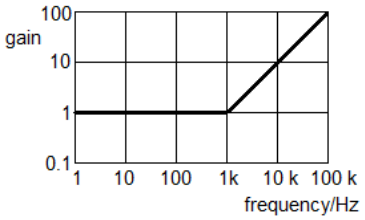
(c) Replace the inverting amplifier with a non-inverting one of the same gain, but an input impedance of 1 MΩ.

3 (a) A tone control allows some frequencies to be amplified more than others.

(b) Bass boost is often necessary when sound is played back at a lower volume than the original recording. This is because human ears find it difficult to pick up low frequency signals at low volume.

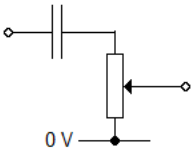


(c) Treble boost filters increase the gain of the system for signals whose frequencies lie above a certain value. This may compensate for the poor transfer characteristic of the loudspeaker.



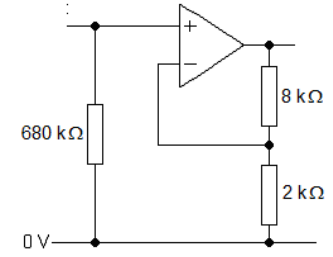
4 (a) $G = 1 + R_f/R_d = 1 + (8/2) = 5$

(b)



(c) $G = -R_f/R_{in} = -1.3\times10^{6} / 3.3\times10^{3} = -39$

(d) Overall gain is the product of the gains = +5 × (0 to 1) × -40 = -200 to 0.



5 (a) R_{total} = 4 + 16 = 20 Ω

loudspeaker current $I = V/R = 2.4 / 20 = 1.2\times10^{-1}$ A

loudspeaker voltage $= IR = 1.2\times10^{-1} \times 16 = 1.9$ V

(b) $P = VI = 1.9 \times 1.2\times10^{-1} = 2.3\times10^{-1}$ W or 230 mW