KTH Computer Science
and Communication

2F1120 Spektrala transformer för Media
Solutions to Steiglitz Chapter 2

Preface

This document contains solutions to selected problems from Ken Steiglitz's book: "A Digital Signal Processing Primer" published by Addison-Wesley. Refer to the book for the problem text.

2.2

From the wave equation 2.5 in the text book we see that the wave velocity c is a function of the tension P:

$$c = \sqrt{\frac{P}{\rho}}$$

If we increase the tension, the velocity will therefore increase.

2.4

As should be clear from the discussion in the text book, in resonance state, only a node can happen at a close end, and only an antinode can happen at an open end. So, while for a tube with one close end the relation between the length of the tube L and the wave length λ is:

$$\lambda = \frac{4L}{n} \qquad n = 1, 3, 5, \ldots$$

for a tube with both open ends the relation is

$$\lambda = \frac{2L}{n} \qquad n = 1, 2, 3, \ldots$$

See Figure 1 for a comparison of the first three modes.

2.5

We pass suddenly from a open end condition to a close end condition. The result is that all the modes are changed from:

$$\lambda = 2L, \quad L, \quad \frac{L}{2}, \quad \frac{L}{3} \ldots$$

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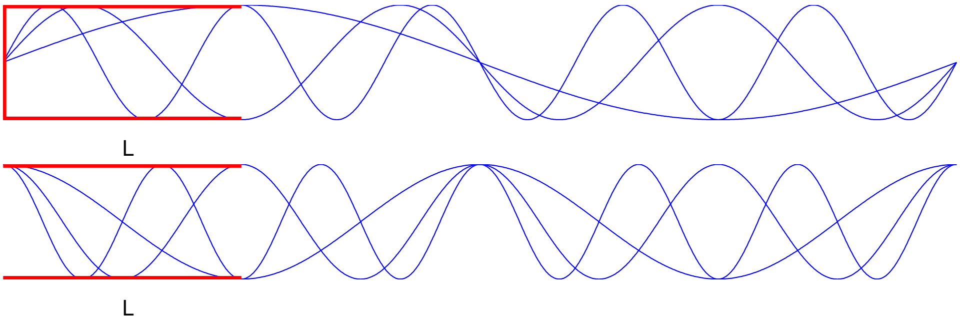

Figure 1. Standing waves for pipes with a close end or two open ends

to

$$\lambda = 4L, \ \ \frac{4}{3}L, \ \ \frac{4}{5}L, \ldots$$

The relation between these modes is displayed in Figure 2. The perceived result is a sudden fall in pitch.

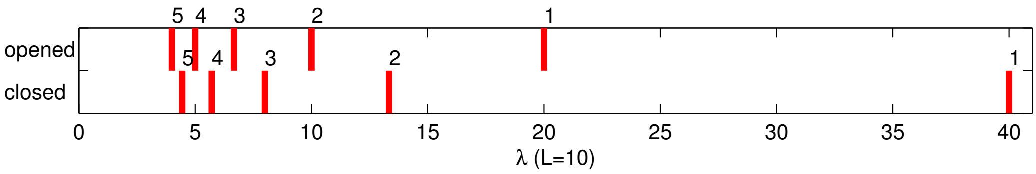

Figure 2. Mode shift from opened to close condition at one end of the tube. Modes are represented by their wave lengths for a tube of length 10 units

2.8

By damping the motion of the centre point in the string you impose a node at that point. This means that the string is equivalent to two strings of half the size. It also means that, of the various harmonics that the original string supported, only the even ones are now possible. The new spectrum is thus now formed by the original spectrum where the odd harmonics, including the fundamental, have been removed, and the rest are somewhat dumped. The perceived pitch is one octave higher.