

CHAPTER 11

Vibrations

The ideal harmonic oscillator (previous chapter) oscillates with simple sinusoidal motion forever. In the real world there is friction so oscillations decay more or less quickly, there are forces that cause the oscillations, and there are multiple parts that move multiple ways. Understanding something about these realities is the topic of this chapter. Some key words are damping, resonance, frequency response and normal modes.

This chapter is a brief introduction to the topic of vibrations. We already know about the harmonic oscillator, and that is the core idea. But here we want to take account of three main ideas, with one section per idea.

1. **Damping.** There is friction, so oscillatory motion decays in time. This is simple enough conceptually, but the mathematical descriptions are more complicated than for the harmonic oscillator, involving a mix of exponential and sine functions.
2. **Forcing.** Things get pushed around, or ‘forced’. What is the relation between how much you push on something and how much it shakes. The key ideas here are resonance and frequency response.

3. **Normal modes.** Most real machines and structures have various moving parts. How do things move with various parts? For simplicity here we stick to the cases with no friction. The key idea is that one can think of the general motions as made up of (as a superposition of) simple harmonic motions. These are called normal modes.