Chapter 4 Case Study: A Speaker Model

(Case study is from Palm Palm, W. J., Modeling, Analysis, and Control of Dynamic Systems)

The basic concept of a speaker is illustrated in Figure 1. A coil that is attached to a diaphragm is allowed to move relative to a permanent magnet. The current in the coil is produced from a stereo or a radio amplifier. As the current is varied, a varying magnetic force is produced on the coil, which causes it and the diaphragm to move. The diaphragm's motion produces air pressure waves, which is sound.

The speaker is an electromechanical system. Figure 2a shows a simplified model of the mechanical subsystem. The mass m represents the combined mass of the diaphragm and the coil. The spring constant k and damping constant c depend on the material properties of the diaphragm. The force f is the magnetic force, which is related to the coil current by $f = K_f i$. Figure 2b shows the electrical subsystem. The coil's inductance and resistance are L and R. The coil experiences a back emf because it is a current conductor moving in a magnetic field (just like the armature circuit in a motor). This back emf is given by $K_e x$. The voltage v is the signal from the amplifier or radio.

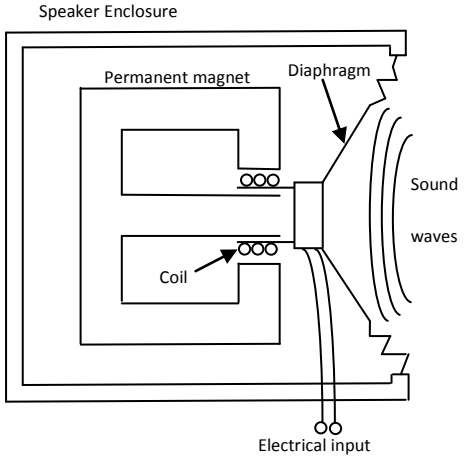

Figure 1 Diagram of a speaker

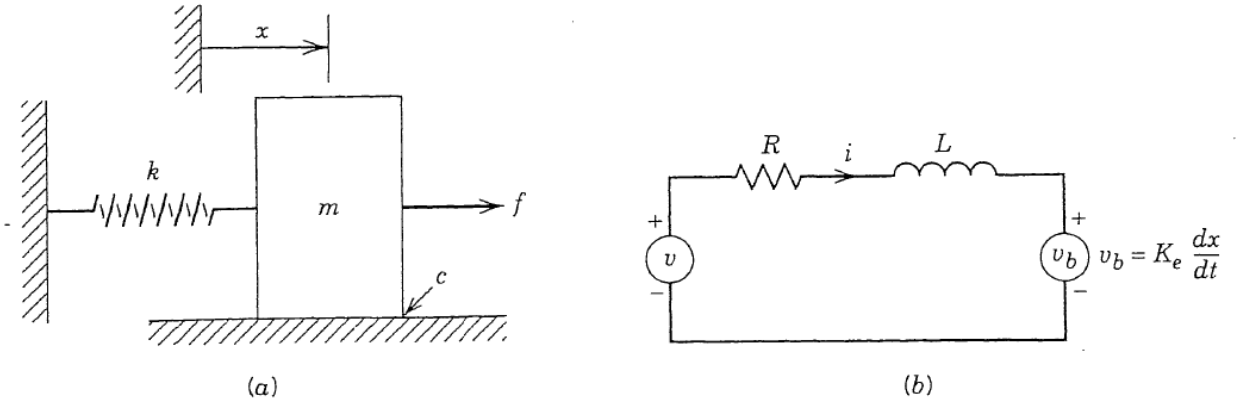

Figure 2. Speaker subsystems. (*a*) Mechanical subsystem. (*b*) Electrical subsystem.