Vibrations of Structures

Module V: Vibrations of Plates

Exercises

1. A square plate of side a is simply-supported at the four edges, and carries a particle of mass m at the center. Determine the eigenfrequencies and eigenfunctions of the plate.

2. A circular plate of radius a is simply supported at the boundary. Determine the dynamic reaction forces at the boundary for different modes of vibration of the plate.

3. An elliptic plate of semi-major axis a and semi-minor axis b is simply supported at the boundary. Determine the approximate eigenfrequencies and modes of vibrations. Plot the variation of the first six eigenfrequencies with the ratio a/b in the range $(1, 2)$.

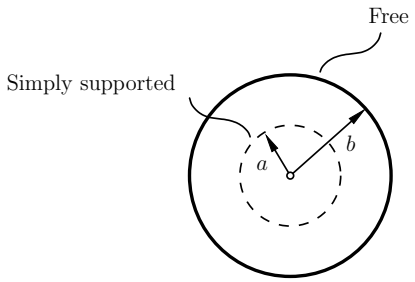

Figure 1: Exercise 4

4. A circular plate of radius a is simply-supported on a circle of radius b, as shown in Fig. 1. Determine the optimum ratio b/a for which the plate is most firmly supported in the mode $(0, 1)$ (*i.e.*, the corresponding frequency is maximized).

5. A circular plate of radius a is clamped at the boundary $r = a$. A particle of mass m is dropped from a height h exactly on the center of the plate. The particle sticks to the plate. Determine the motion of the plate and the force between the particle and the plate.

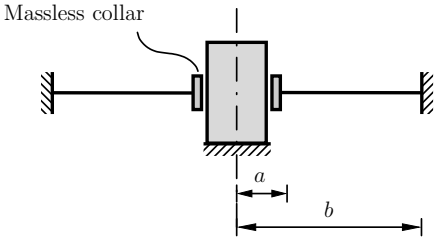

Figure 2: Exercise 6

6. An annular plate of inner radius a and outer radius b is clamped at the boundary $r = b$, and clamped to a massless collar (at $r = a$) sliding without friction on a guide, as shown in Fig. 2. Determine the eigenfrequencies and eigenfunctions of the system. If the collar is excited by a harmonic force $Q(t) = A \cos \Omega t$, determine the response of the plate.

7. A circular plate of radius a is clamped at the boundary. A constant point force is traveling on a circular path around the center of the plate at a radius r_0, *i.e.*, $q(r, \phi, t) = Q_0\delta(r-r_0)\delta(\phi-\Omega t)$, where Q_0 is the constant magnitude, and Ω is the angular speed. Determine the response of the plate. At what values of Ω will the plate resonate?

8. A square plate of side a is simply supported at the edges on a rigid frame. The frame is given harmonic angular oscillations of circular frequency Ω about a center line parallel to an edge. Determine the response of the plate.