VIBRATION EXPERIMENTS FOR STUDENTS

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Introduction

The purpose of this report is to demonstrate some experiments for teaching vibration principles to students.

Chaldni Patterns

The purpose of the first experiment is to determine the natural frequencies and mode shapes for a common baking pan, using Chladni patterns. The pan had a thickness of 0.5 mm and a diameter of 0.229 m. The material was stainless steel. The bottom of the pan represented a circular plate.

An electromagnetic shaker was used to excite the bottom of the pan. Note that an electromagnetic shaker is similar to a loudspeaker. A sine function generator was used to drive the shaker, as shown in Figure 1. The frequency of the sine function was varied until mode shapes formed. Salt particles were used to trace the nodal lines for each mode shape. The experimental results are shown in Figures 2 through 8

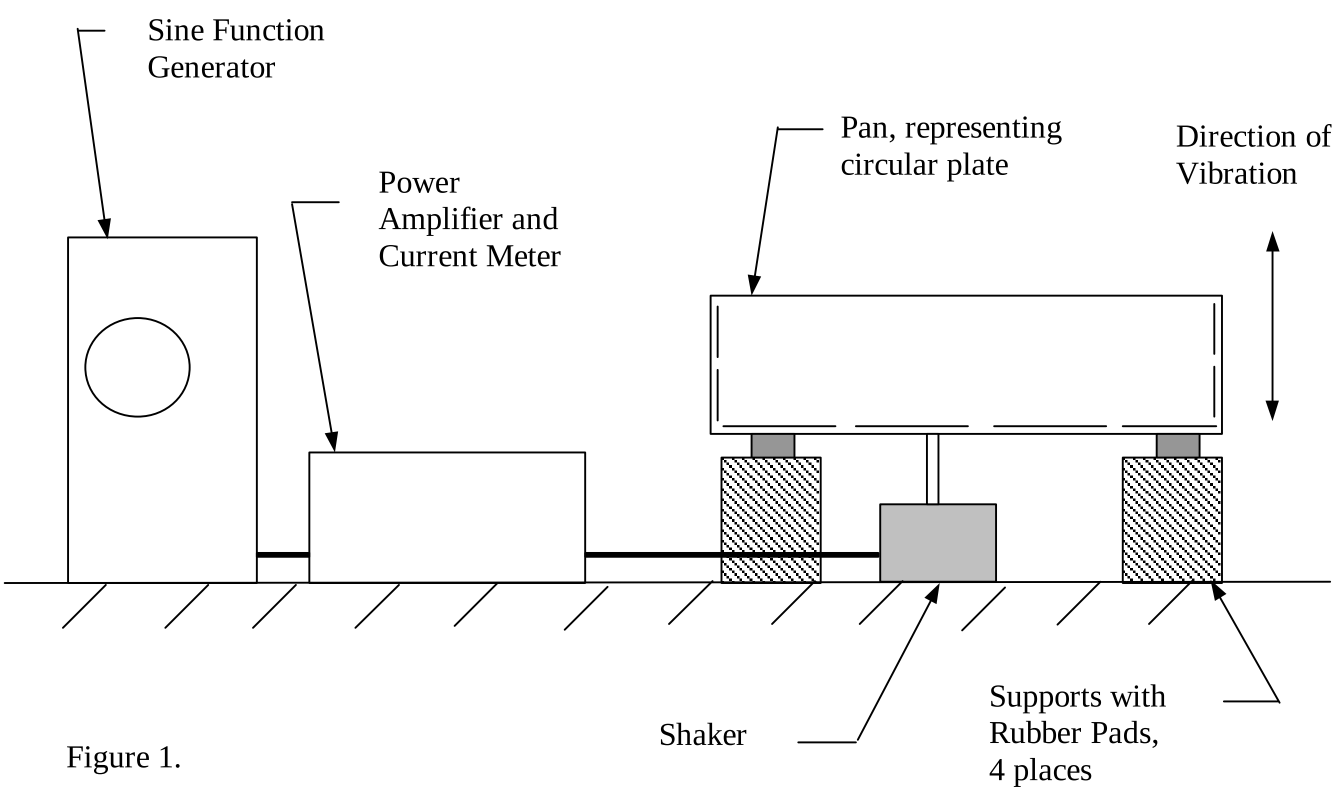

Figure 1.

Figure 2. First Bending Mode, "Oil Can Mode," 110 Hz

Figure 3. Second Bending Mode, One Diameteral Nodal Line, 230 Hz

Figure 4. Third Bending Mode, Two Diameteral Nodal Lines, 400 Hz

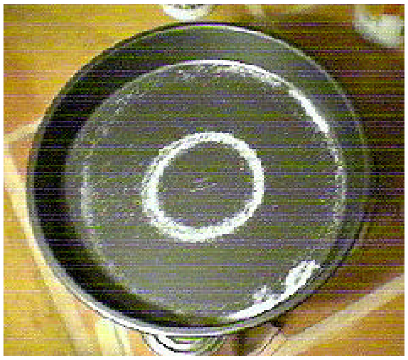

Figure 5. Fourth Bending Mode, One Circular Nodal Line, 495 Hz

Figure 6. Fifth Bending Mode, Three Diameteral Nodal Lines, 600 Hz

Figure 7. Sixth Bending Mode, One Circular and One Diameteral Nodal Line, 720 Hz

Figure 8. Eighth Bending Mode, One Circular and Two Diameteral Nodal Lines, 980 Hz

Note: The seventh bending mode, which should have four diameteral nodal lines, was not recorded.

MODEL AIRCRAFT

For the second experiment, a model of an F-15 aircraft was suspended underneath a support frame via elastic cords. An electromagnetic shaker was positioned underneath the fuselage.

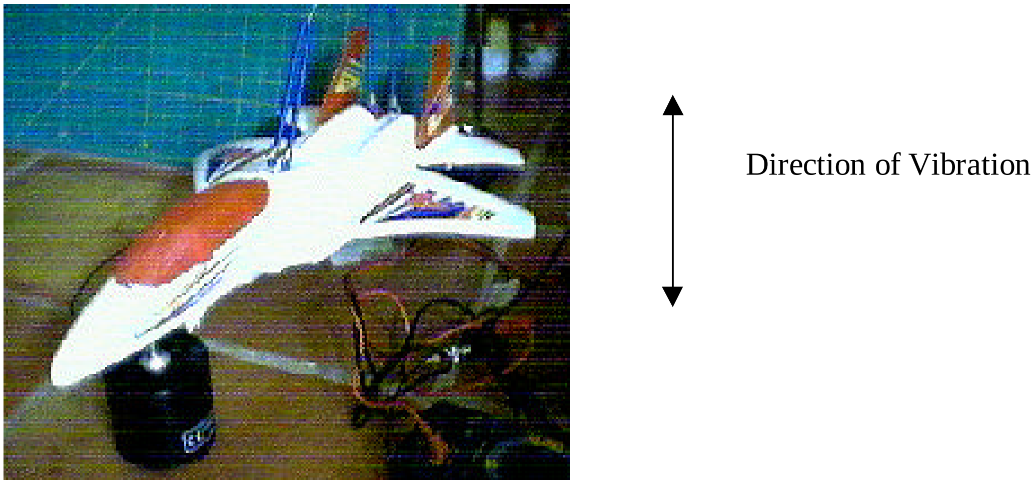

Figure 9.

A sinusoidal signal was applied to the shaker. The frequency of the sine function was varied to determine the natural frequencies of the model. Natural frequencies were found at 30 Hz and 60 Hz, as shown in Figures 10 and 11, respectively.

Figure 10. Resonant Excitation of the Wings at 30 Hz

Figure 11. Resonant Excitation of the Horizontal Stabilizer at 60 Hz.

The resonant motion of the horizontal stabilizer has a small displacement because it occurs at a relatively high natural frequency.