

Homework – Lecture 3

Problem 3.1

An automobile deflects its suspension spring 0.02 m under static conditions. Determine the natural frequency of the automobile in the vertical direction.

Problem 3.2

Problem 2.69 in Rao

Problem 3.3

A very large luxury liner once had a vibration problem that was critical to its operation until the problem was corrected. The ship had four propellers, each has a mass of 12,200 kg and each was driven by a long hollow shaft, 0.56 m OD and 0.28 m ID (which gives a cross sectional area of 0.185m^2 and a mass moment of inertia about its longitudinal axis of $598\text{ kg}\cdot\text{m}^2$), and 71.6 m long. When the ship was cruising the shaft had a speed of 258 rpm. Assume Young's modulus is $2.05 \times 10^{11}\text{ N/m}^2$.

- Determine the natural frequency for longitudinal vibration of the propeller and the shaft neglecting the mass of the shaft. (Ans. $\approx 208\text{ rad/s}$)
- If the mass of the shaft is 99,200 kg, determine the natural frequency of longitudinal vibration considering the mass of the propeller and the shaft. (Ans. $\approx 108\text{ rad/s}$)
- What will happen if the ship is equipped (which it was) with four-bladed propellers? How would you correct this problem?

