UNSW Australia

School of Mechanical and Manufacturing Engineering

MMAN2300 Engineering Mechanics 2

Part A: Vibration Analysis

Tutorial 1

Q1. The free response of an under-damped single DOF spring-mass-damper system is measured. At t_1, the amplitude is 9 mm. One period later, the amplitude is 1mm. If the mass and stiffness of the system are 2 kg and 1.5×10^3 N/m respectively, calculate the damping coefficient.

Q2-Q5. For a damped system, *m*, *c*, and *k* are known to be 1 kg, 2 kg/s and 10 N/m respectively. Calculate the values of ζ, ω_n and ω_d. Is the system over-damped, under-damped or critically damped?

Q6-Q8. For a single DOF spring-mass system in free vibration, we can use the following general solution:

$$x(t) = B\sin(\omega_n t) + C\cos(\omega_n t)$$

Calculate the values of ω_n, B and C for a single DOF spring-mass system with a spring stiffness of $k = 4\,\text{N/m}$, mass $m = 1\,\text{kg}$, and initial conditions $x_o = 0.001\,\text{m}$ and $\dot{x}_o = 0\,\text{m/s}$. Solve for $x(t)$.

Q9. A spring-mass system with viscous damping has a mass of $6\,\text{kg}$ and a spring constant of $15\,\text{kN/m}$. In free vibration, the amplitude decreases to 0.2 of the initial value after seven consecutive cycles. Evaluate the damping coefficient of the damper.

Q10-Q11. Sketch the responses (as a function of time) for (i) an under-damped, (ii) an over-damped, and (iii) a critically damped single DOF spring-mass-damper system in free vibration. Discuss the rate at which each system comes to rest.