Mechanical Vibrations – Final Examination
(Graduate School)
Upload deadline: 2021/06/22 24:00

1. **A damped single degree of freedom mass-spring system consists of a m=5kg mass suspended by a linear spring which has a stiffness coefficient of k=500N/m. From the experimental measurements, it was observed that the amplitude of vibration diminishes from 0.02m to 0.012m in 6 cycles. Determine the damping coefficient c. (10%)**

2. **As shown in Fig. 1, a single degree of freedom mass-spring system consists of a m=5kg mass suspended by a linear spring which has a stiffness coefficient of k=5000N/m. The system is subjected to the friction force by the coefficient of dry friction μ=0.1. The mass is given an initial displacement of 0.03m and an initial velocity of 0m/s. Determine the system (a)Differential equation of motion, (b)The number of cycles of oscillation of the mass before it comes to rest. (10%)**

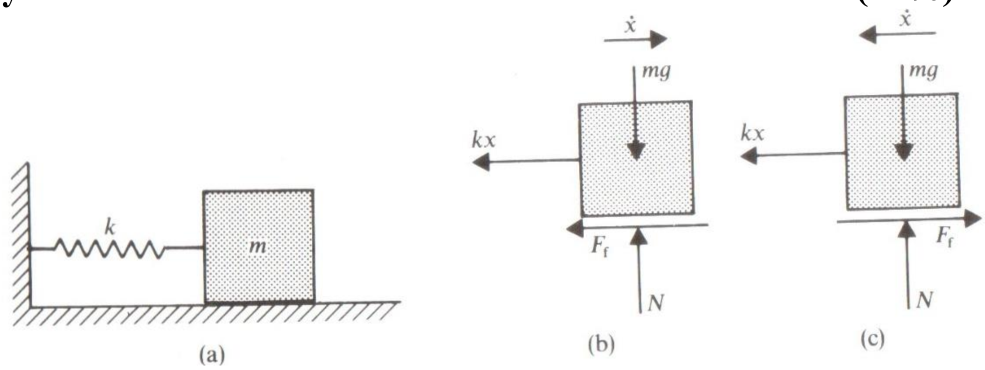

Fig. 1

3. **A damped single degree of freedom mass-damper-spring system consists of a m=10kg mass suspended by a linear damper which has a damping coefficient of c=40N*s/m and a linear spring which has a stiffness coefficient of k=4000N/m. The amplitude of the forcing function F=60N, and the frequency ω_f=40rad/s. The mass is given an initial displacement of 1m and an initial velocity of 0m/s. Determine (a)The damping factor, (b)The magnification factor (amplitude ratio), (c)The displacement response, (d)The transmissibility and amplitude of the force transmitted to the support. (10%)**

4. **A single degree of freedom mass-spring system is such that an amplitude loss of 25% occurs in every five full cycles of oscillation. Obtain the damping factor of this vibration system. (10%)**

5. **A single degree of freedom system is subjected to a periodic forcing function f(t) as show in Fig. 2. Determine the Fourier Series representation for f(t). (10%)**

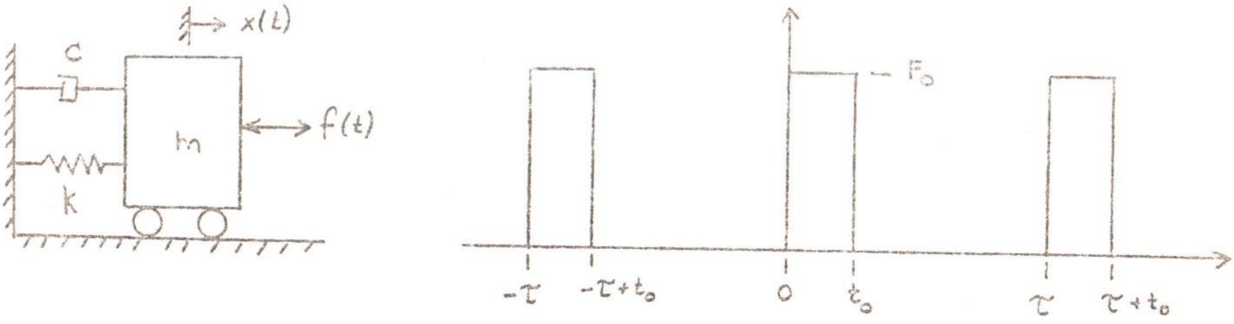

Fig. 2

6. **For the system shown in Fig. 3, let m=0.5kg, a=0.2m, l=0.4m, k=3000N/m. Determine the damping coefficient c if: (a)The system is underdamped with ξ=0.09, (b) The system is critically damped, (c) The system is overdamped with ξ=1.2. (10%)**

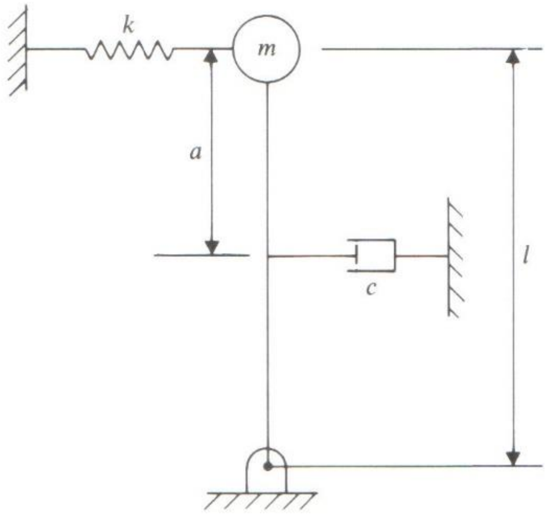

Fig. 3

7. **For the two degree of freedom undamped free system shown in Fig. 4, let m_1=1kg, m_2=2kg, and k_1=k_2=100N/m, k_3=200N/m and let x_{10}=1.2, x_{20}=0, $\dot{x}_{10}$=0 and $\dot{X}_{20}$=0. Determine the system modal natural frequency and the system response as a function of time. (10%)**

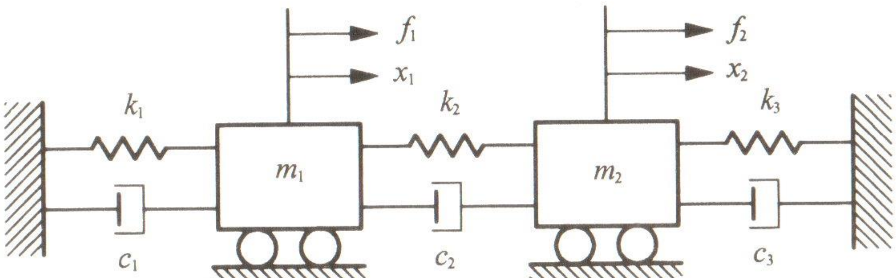

Fig. 4

8. (a) For the system shown in Fig. 5, derive the differential equation of motion for small oscillation. If $m_1 = m_2 = 1$ kg, $k_1 = k_2 = 1000$ N/m, $C_1 = C_2 = 10$ N-s/m, $a = b = 0.5$ m, and $l = 1$ m, find the solution after 1 second provided that the initial angular displacement is zero and the initial angular velocity is 5 rad/s. Assume that the rod is massless. (10%)
(b) If this vibration system is critically damped, please determine the relationship between the damping coefficients C_1 and C_2 in this problem. (5%)

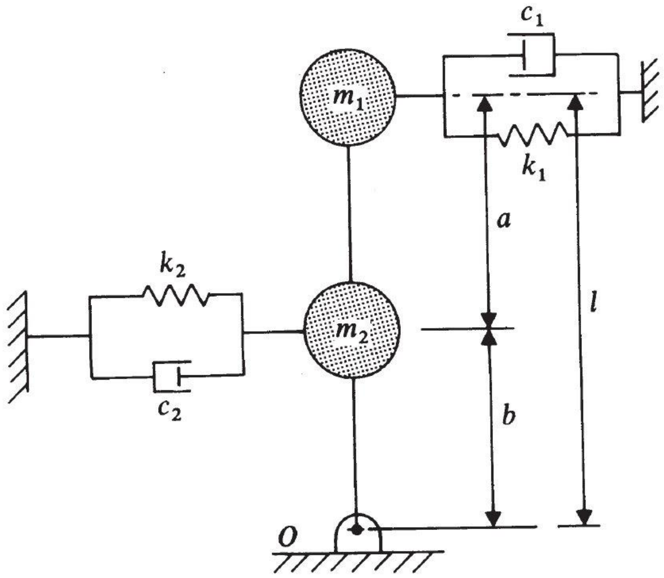

Fig. 5

9. (a) Derive the differential equation of motion of the simple vehicle model shown in Fig. 6. The vehicle is assumed to travel over the rough surface with a constant vehicle speed v. Obtain also the steady state response of the vehicle. (5%)
(b) Let $m = 10$ kg, $k = 4000$ N/m, $c = 150$ N-s/m, $\lambda = 2$m, and the amplitude $Y_o = 0.1$ m. Determine the maximum vertical displacement of the mass and the corresponding vehicle speed. Determine also the maximum dynamic force transmitted to the mass at the resonant speed. (10%)

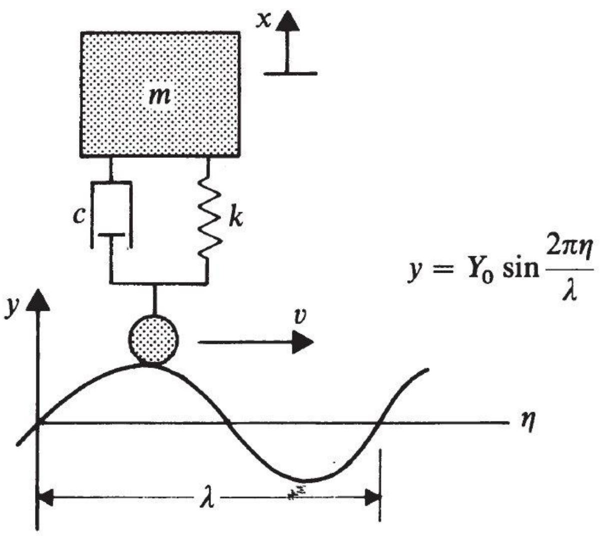

Fig. 6

10. (a) Obtain the Fourier series expansion of the periodic function F(t) shown in Fig. 7. (10%)
(b) Determine the forced response of the single degree of freedom system shown in Fig. 8 to the periodic forcing function F(t) shown in Fig. 7. (5%)

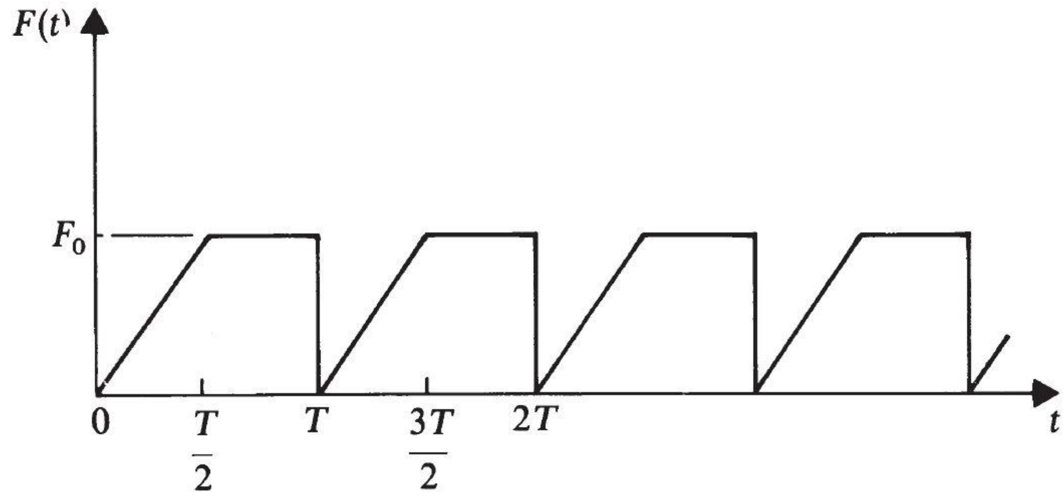

Fig. 7

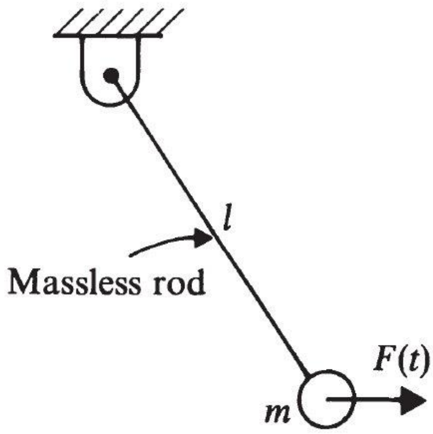

Fig. 8

1. Please submit the solution of final examination as soon as possible.
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