Fayoum University		3rd Year Industrial Engineering
Faculty of Engineering		Final Exam – Jan., 2015
Inustrial Engineering Dept.	Mechanical Vibration	Full Marks: 60, Time:3 Hours

Answer all the following questions:

Question (1)

1. Define the logarithmic decrement of a free-damped vibration δ and specific loss, and prove that

$$\delta \approx 2\pi\zeta \quad \text{and} \quad Specific\ \ loss \approx 2\delta$$

2. A slider-crank mechanism is used to impart motion to the base of a spring-mass-damper system, as shown in **Figure (1)**. Approximating the base motion $y(t)$ as a series of harmonic functions, drive the equation of motion and find the response (natural frequency, damping ratio) of the mass for m = 1 kg, c = 10 N-s/m, k = 100 N/m, r = 10 cm, l = 1 m, and ω = 100 rad/s.

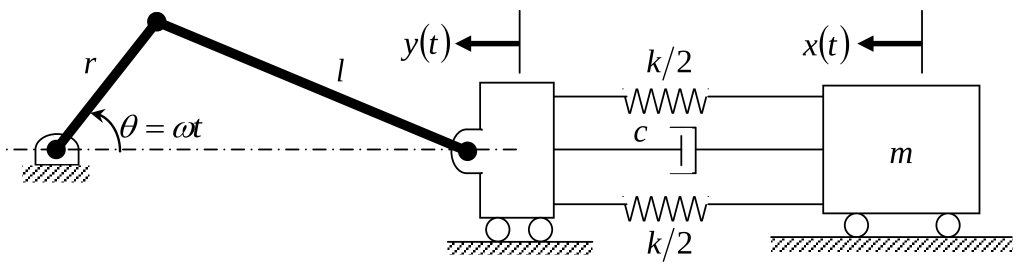

Fig. (1).

Question (2)

1. What is meant by unrestrained (semi-definite) two-degree-of-freedom system? How many natural frequencies can be zero for it?

2. **Figure (2)** is a diagram of an automobile. Mass = 2000 *kg*, Wheel base = 3 *m*, center of gravity (C.G.) is 1.4 *m* from front axle, and radius of gyration about C.G. = 1.1 *m*. If the spring constants are of front and rear springs are 6040 and 6500 kgf/cm respectively, determine the natural frequency of the car. Also find the principal modes of vibration and the motions $x(t)$ and $\theta(t)$.

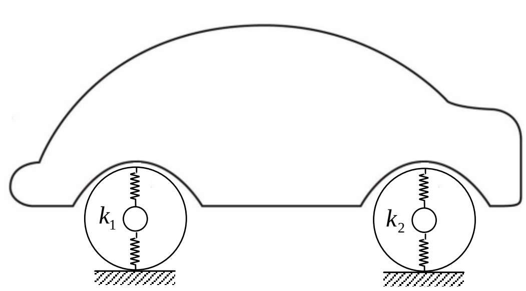

Fig. (2).

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Question (3)

1. Determine the Fourier series expansion of the motion of the valve in the cam-follower system shown in **Figure (3)**

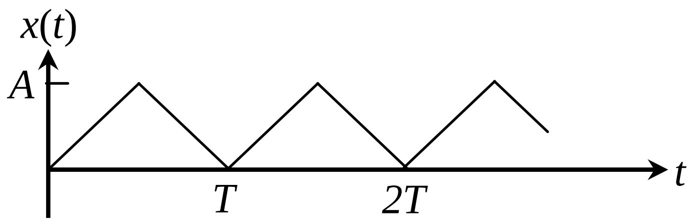

Fig. (3).

2. Find the torsional natural frequencies and the mode shapes of the rotor system a shown in **Figure (4)**. B_1 and B_2 are fixed supports and D_1 and D_2 are rigid discs. The shaft is made of steel with modulus of rigidity $G = 0.8\times10^{11}$ N/m^2 and uniform diameter d = 10 mm. The various shaft lengths are as follows: B_1D_1 = 50 mm, D_1D_2 = 75 mm, and D_2B_2 = 50 mm. The polar mass moments of inertia of discs are: J_{d1} = 0.08 kg-m^2 and J_{d2} = 0.2 kg-m^2. Consider shaft as massless.

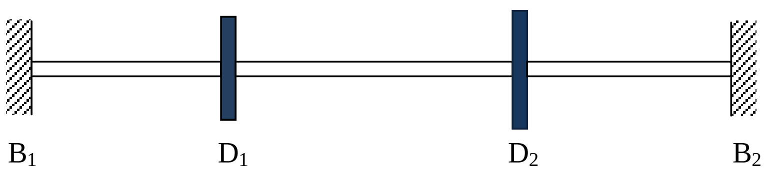

Fig. (4).

Question (4)

1. What are the various methods available for vibration control, with examples?

2. A flexible machine part was observed to vibrate badly at frequency of 20 Hz. The vibration was caused by the application of a harmonic force of unknown amplitude to the flexible part. A judgment was made that the vibration was excessive because the frequency of the harmonic force coincided with the natural frequency of the flexible part.
   a) When the harmonic force was not present, a 0.5 kg mass was placed on the flexible part, and a static displacement of 3 mm was observed. If the flexible part was be modeled as a spring-mass-damper system, what value of equivalent stiffness k and mass m would be appropriate?
   b) Design an absorber with a mass of 0.03 kg that would eliminate vibrations of the flexible part at frequency of 20 Hz.
   c) If the amplitude of the motion of the absorber mass at 20 Hz was observed to be 1 cm, what was the amplitude of the harmonic force that caused the flexible part to vibrate?

Best wishes

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