ACHARYA INSTITUTE OF TECHNOLOGY
Bangalore - 560090

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10AU73

# Seventh Semester B.E. Degree Examination, Dec.2016/Jan.2017
## Mechanical Vibrations and Vehicle Dynamics

Time: 3 hrs. Max. Marks:100

**Note:** ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***



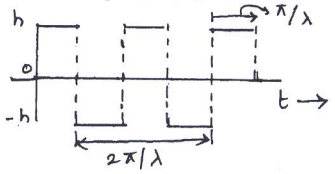


### PART – A

1 a. A body is subjected to two harmonic motions $x_1 = 15 \sin(wt + \frac{\pi}{6})$ ; $x_2 = 8 \cos(wt + \pi/6)$. What harmonic is to be given to the body to bring it to equilibrium? **(08 Marks)**

b. Explain the rectangular wave shown in fig. Q1(b) in Fourier series. **(06 Marks)**

Fig.Q1(b)



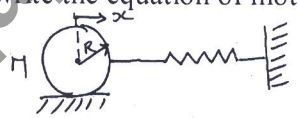

c. Classify the vibration for following examples i) Vibration of cantilever beam ii) Up and down motion of spring mass system iii) Twisting of disc on the shaft. **(03 Marks)**

d. Define the following : i) Degrees of freedom ii) Resonance iii) Non – linear vibrations. **(03 Marks)**

2 a. A solid wooden cylinder of diameter D and heigh H floats partially immersed in water. Find the natural frequency of free vertical oscillations of the cylinder. **(05 Marks)**

b. A circular cylinder of radius R and mass M is held by spring as shown in fig. 2(b). if the body rolls on horizontal surface, write the equation of motion using Energy method.

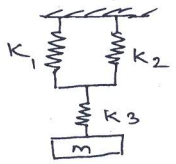
Fig.Q2(b)




Also find out the equivalent mass of system. **(06 Marks)**

c. Obtain the natural frequency of the system as shown in fig. 2(c). **(09 Marks)**

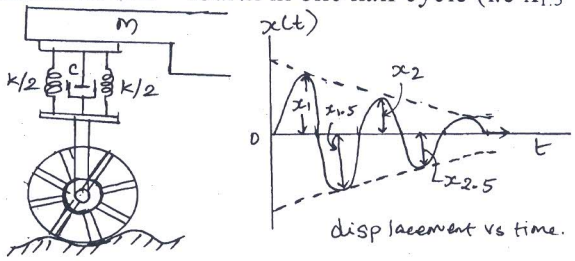
Fig.Q2(c)




m = 10g N
K1 = 10 N/mm
K2 = 10 N/mm
K3 = 5 N/m

3 a. An under damped shock absorber is to be designed for a motor cycle of mass 200kg. When a shock absorber is subjected to an initial velocity (vertical) due to road bump, the resulting displacement – time curve is as shown fig, Q3(a). Find the necessary stiffness and damping constants of the shock absorber if the damped period of vibration is to be 2s and the amplitude $x_1$ is to be reduced to one – fourth in one half cycle (i.e $x_{1.5} = x_1/4$). **(10 Marks)**

Fig.Q3(a)




Also find the minimum initial velocity that leads to a maximum displacement of 250mm.

b. With suitable graph, explain the different types of stability of the system. **(05 Marks)**

c. Show that the logarithmic decrement can be depressed as $\delta = \frac{1}{n}\left(\log_e \frac{x_0}{x_n}\right)$. Also show that, if the number of cycles needed for the amplitude to diminish by half is n, then n = 0.1103/n. **(05 Marks)**

4 a. A circular steel shaft of diameter 20mm and length 1m carries a thin disk of mass 0.67kg and diameter 100mm. The disk is under a harmonic torque of amplitude 12N-m at 628 rad/S. Find the steady – state angular oscillation amplitude of the disk, neglecting damping. Assume $G = 8 \times 10^{10}$ N/m$^2$, $\rho = 7500$ kg/m$^3$. **(08 Marks)**

b. An industrial chimney of diameter 0.8m has a natural frequency of $f_n = 2$Hz. Find the wind velocity at which the chimney may vibrate maximum. Also comment about the axis of vibration. **(04 Marks)**

c. An engine mounting system was excited harmonically at various frequencies to construct a resonance curve. It was found that at $f_1 = 22.083$Hz, the amplitude was 0.05 unit and this increased to the peak value of 0.1 unit at $f_p = 27.5$ Hz. Find the damping in the mounting. **(08 Marks)**



## PART – B

5 a. A rotor mass of 10kg is mounted at the shaft supported by rigid bearing at its ends. The diameter of the shaft is 15mm and the length is 0.5m. The disk centre of gravity and geometric centre of the rotor are separated by 0.03mm. If the system is rotating at 3000 rpm, find i) the critical speed ii) the amplitude of vibration iii) the dynamic force on the bearings. Assume $E = 2 \times 10^{11}$ N/m$^2$. **(08 Marks)**

b. Explain the following with neat sketch :
i) Piezoelectric accelerometer ii) Phase distortion. **(08 Marks)**

c. A vibrometer having natural frequency of 4 rad/s and $\zeta$ (zeta) = 0.2 is attached to a structure that performs harmonic motion. If the difference between maximum and minimum recorded value is 8mm, find the amplitude of motion of the vibrating structure when its frequency is 40 rad/S. **(04 Marks)**

6 a. Determine the Pitch (angular motion) and bounce (up and down linear motion) frequencies and the location of oscillation centres (nodes) of an automobile with following data as shown in fig.6(a). **(10 Marks)**

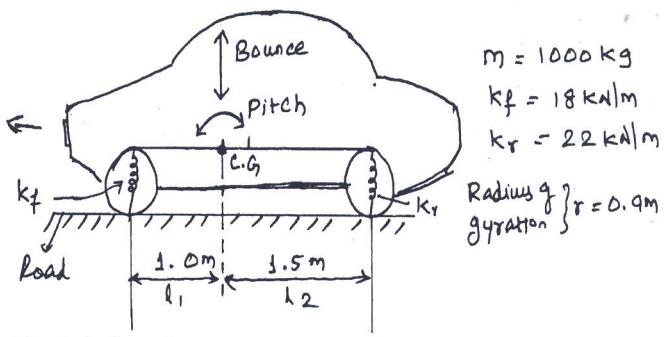



Fig.Q6(a)

b. Write short note on Tuned absorber. **(03 Marks)**

c. A two degree of freedom system is subjected to a harmonic force F sin λ t as shown in fig. Q6(c). Find the forced response using the principal coordinates of the system. **(07 Marks)**

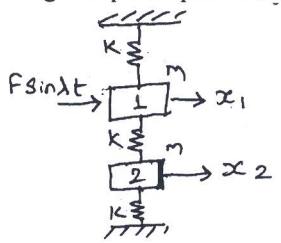



Fig.Q6(c)

7 a. How do you increase the natural frequency of Automotive components or system, without increasing the mass? Explain briefly. **(03 Marks)**

b. An exhaust fan rotating at 1000 rpm, is to be supported by four springs, each having a stiffness of K. If only 10% of the unbalanced force of fan is to be transmitted to the base, what should be the value of K? Assume mass of exhaust fan to be 40kg and transmissibility as 0.1. **(07 Marks)**

c. A compressor at a speed of 240 rpm, it was found that a pipe in a plant vibrated violently. To eliminate the vibrations a trial mass of 1kg tuned to 240 cpm was suspended on the pipe. This resulted in a two natural frequencies 200 and 280 cpm. Design the absorber such that the natural frequencies lie outside the range of 150 to 300 cpm. **(10 Marks)**

8 a. A wedge shaped bar (triangular in plan) is fixed at the left and free at the right end as shown in fig. Q8(a). Find the fundamental frequency of longitudinal oscillation of the wedge using Rayleigh's approximations. **(10 Marks)**

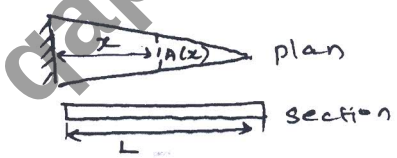



Fig.Q8(a)

b. A machine part resonated at 30Hz when excited by a shaker weighing 0.75kg. The resonant frequency reduced to 25Hz, when extra 0.75kg was added to shaker. What is the true frequency of the machine part? Use Dunkerley's method. **(10 Marks)**

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