Paper / Subject Code: 88804 / Mechanical Vibrations

TE/Sem VI/CBCGS/AUTO/MJ2019/28-05-2019

(3 Hours) Total marks: 80

Instructions:

- **Question No. 1 is compulsory.**
- **Attempt any 3 out of the remaining questions.**
- **Assume suitable data whenever required with proper justification.**

Q1 Attempt **any four** of the following. All sub questions carry equal marks. **(20)**

(a) Explain the three basic steps of vibration analysis.

(b) Explain working principle of Fullarton tachometer.

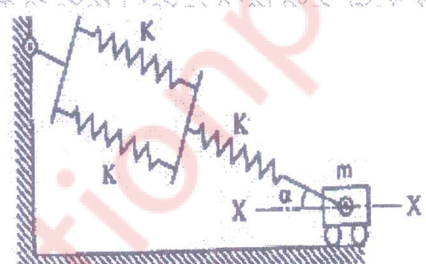
(c) A wheel is mounted on a steel shaft ($G = 8 \times 10^{10}$ N/m^2) of length 1.5 m & radius 80 cm. The wheel is rotated through 5° & released. The period of oscillations is observed as 2.3 sec. Determine the mass moment of inertia of the wheel.

(d) Why is the balancing of rotating parts necessary for high speed engines? How are the different masses rotating in different planes balanced?

(e) A vibrating system consists of a mass 1 kg, a spring of stiffness 1 N/mm and a damper of damping coefficient 0.05 Ns/mm. Determine (i) damping factor (ii) Frequency of damped vibration.

(f) How to determine the critical speed of shaft having single rotor without damping.

Q2(a) A mass m guided in X-X direction is connected by spring configuration as shown in figure below. Set up the equation of mass 'm' and find the natural frequency of vibration of mass. **(10)**



Q2(b) A truck carries carton weighing 150 kg. The carton is placed on the truck floor and is supported by a spring of stiffness 1500 N/m. The coefficient of friction between the truck floor and carton is 0.5. The truck while traveling is braked, causing it to decelerate by 8 m/s^2. Find: (i) The initial displacement of the carton inside the truck. (ii) The natural frequency of the carton. (iii) The final position of the carton. **(10)**

Q3(a) The disc of torsional pendulum has moment of inertia of 600 $kg\text{-}cm^2$ and is immersed in a viscous fluid. The brass shaft attached to it is of 10 cm diameter and 40 cm long. When the pendulum is vibrating, the observed amplitudes on the same side of the rest positions for successive cycles are 9°, 6° and 4°. Determine: (i) Logarithmic decrement. (ii) Damping torque, assuming unit angular velocity. (iii) The periodic time of vibrations. For brass shaft, take $G = 4.4 \times 10^{10}$ N/m^2. **(10)**

Q3(b) An instrument panel of aircraft is mounted on isolators. If the isolators have very little damping and they deflect 3 mm under weight of 23 kg, find the percentage of motion transmitted to the instrument board if the vibration of aircraft happens at 2000 rpm. **(10)**

Q4(a) It is required to measure the maximum acceleration of a machine which vibrates violently with frequency of 700 cycles/min. An accelerometer with negligible damping is attached to it and the indicator travels by 8.2 mm. If the accelerometer weighs 0.5 kg and has spring rate of 17,500 N/m, what is the maximum amplitude and maximum acceleration of the machine? **(10)**

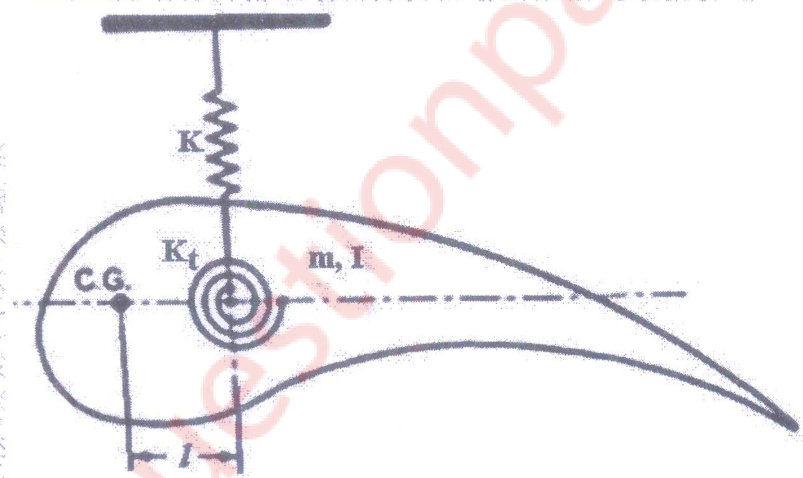
Q4(b) Four pulleys are equally spaced along a shaft and each has an out of balance mass at the same radius. The out of balance mass in second pulley is 3 kg, and the third and fourth out of balance masses are at 72° and 220° to it. Determine the masses in the first, third and fourth pulley. Also, find the angle of first mass relative to second, if complete balance is to be obtained. **(10)**

Q5(a) 20 N at 30 cm, 30 N at 60 cm, 10 N at 100 cm from the fixed end are loading on the on the cantilever. The deflection due to all loads is 2 mm. What would be natural frequency of transverse vibration if 20 N is added at 80 cm from the fixed end? The deflection at section 'i' due to unit load at section 'j' is given by: **(14)**

$U_{ij} = U_{ji} = \frac{S_i^2 (3S_j - S_i)}{Constant}$ where, S_i is the distance of section 'i' from fixed end.

Q5(b) Is the phase angle corresponding to the peak amplitude of viscously damped system ever larger than 90°? Explain. **(06)**

Q6(a) Figure below shows aerofoil wing connected through a linear spring of stiffness K and torsional spring of stiffness K_t. Determine the equations of motion for the system and determine the natural frequencies when m = 6 kg, I = 0.10 kg-m, K = 3000 N/m, K_t = 250 Nm/rad, and l = 0.15 m.



Q6(b) Compare Dunkerley's and Rayleigh methods for analyzing beam vibrations. **(06)**
