

Time: 3 Hours

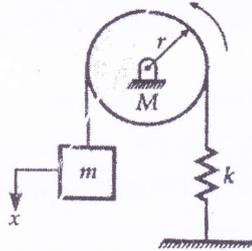
Total Marks: 80

Instructions:

- i. Question No.1 is compulsory
- ii. Attempt any 3 out of the remaining questions
- iii. Use your judgement for unspecified data, if any but justify the assumption.
- iv. Numbers to the right indicate marks.

- Q1. Attempt any four of the following sub questions: (20)
- a. Explain the terms : Logarithmic decrement, Magnification factor. Also mention the significance of logarithmic decrement (5)
 - b. What do you mean by critical speed of a shaft, derive an expression for critical frequency for an undamped shaft. (5)
 - c. Why does gyroscopic couple occurs. Derive an expression for Gyroscopic couple from first principle. (5)
 - d. Compare vibrometer and accelerometer on the basis of the following parameters: mass, natural frequency, practical applicability and error estimation. (5)
 - e. State the different types of governors. What is the difference between centrifugal and inertia type governors? (5)
- Q2.a A mass of 50 kg is suspended by a spring of stiffness 12 kN/m and acted on by a harmonic force of amplitude 40 N. The viscous damping coefficient is 100 N.s/m. Find : (10)
- (i) Resonant amplitude
 - (ii) Peak amplitude
 - (iii) Peak frequency
 - (iv) Resonant phase angle
 - (v) Peak phase angle.
- Q2.b The mass of a turbine rotor of a ship is 8 tonnes and has a radius of gyration 0.6 m. It rotates at 1800 r.p.m. clockwise when looking from the stern. Determine the gyroscopic effects in the following cases: 1. If the ship travelling at 100 km/h steers to the left in a curve of 75 m radius, 2. If the ship is pitching and the bow is descending with maximum velocity. The pitching is simple harmonic, the periodic time being 20 seconds and the total angular movement between the extreme positions is 10° , and 3. If the ship is rolling and at a certain instant has an angular velocity of 0.03 rad/s clockwise when looking from stern. (10)
- Q3.a A vertical petrol engine 100 mm diameter and 120 mm stroke has a connecting rod 250 mm long. The mass of the piston is 1.1 Kg. The speed is 2000 r.p.m. On the expansion stroke with a crank 20° from top dead centre, the gas pressure is 700 KN/mm^2 . Determine net force on the piston, resultant load on the gudgeon pin, thrust on the cylinder wall, speed at which the gudgeon pin load would be reverse in direction. (10)
- Q3.b A vibratory system in a vehicle is to be designed with the following parameters: (10)
- $k = 100 \text{ N/m}$, $C=2 \text{ N-sec/m}$, $m=1\text{kg}$ Calculate the decrease of amplitude from its starting value after 3 complete oscillations and the frequency of oscillation.

- Q4.a In a governor of the Hartnell type, the mass of each ball is 1.5 kg and the lengths of the vertical and horizontal arms of the bell crank lever are 100 mm and 50 mm respectively. The fulcrum of the bell crank lever is at a distance of 90 mm from the axis of rotation. The maximum and minimum radii of rotation of balls are 120 mm and 80 mm and the corresponding equilibrium speeds are 325 and 300 rpm. Find the stiffness of the spring and equilibrium speed when the radius of rotation is 100mm. (10)
- Q4.b Find the natural frequency of the system shown in figure by no slip. (10)



- Q5.a A shaft carries four masses in parallel planes A, B, C and D in this order along its length. The masses at B and C are 18 kg and 12.5 kg respectively, and each has an eccentricity of 60 mm. The masses at A and D have an eccentricity of 80 mm. The angle between the masses at B and C is 100° and that between the masses at B and A is 190° , both being measured in the same direction. The axial distance between the planes A and B is 100 mm and that between B and C is 200 mm. If the shaft is in complete dynamic balance, determine:
1. The magnitude of the masses at A and D; 2. the distance between planes A and D; and 3. the angular position of the mass at D. (10)
- Q5.b A machine of mass 1000 kg is acted upon by an external force of 3000 N at 1800 rpm. To reduce the effect of vibrations, isolators having static deflection of 2 mm under the machine weight and damping factor of 0.2 are used. Determine: (10)
(i) Amplitude of vibration of machine
(ii) Force transmitted to the foundation
(iii) Phase lag and
(iv) Phase angle between transmitted force and exciting force.
- Q6.a Explain what do you mean by Dynamically Equivalent systems. State the conditions for systems to be dynamically equivalent. (6)
- Q6.b Explain vibration-based condition monitoring and fault diagnosis in rotating machine (7)
- Q6.c The natural frequency and the damping ratio of a vibrometer are 6 Hz and 0.22 respectively. What is the range of frequencies for the measurement error to be below 3%. (7)