Time: 3 Hrs **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 what you mean by Dynamically Equivalent systems. State the conditions for systems to be dynamically equivalent. (5)

b. What do you mean by critical speed of a shaft, derive an expression for critical frequency for an undamped shaft. (5)

c. Compare viscous and coulomb damping. Mention at least five points of difference. (5)

d. Explain the terms: Logarithmic decrement, Magnification factor. Also mention the significance of logarithmic decrement. (5)

e. Why does gyroscopic couple occurs. Derrive an expression for Gyroscopic couple (5)

Q2.a A body of mass 70 kg is suspended from a spring which deflects 2.0 cm under the load. It is subjected to a damping effect adjusted to a value 0.23 times that required for critical damping. Find the natural frequency of the undamped and damped vibrations and ratio of successive amplitudes for damped vibrations. (10)
If the body is subjected to a periodic disturbing force of 700 N and of frequency equal to 0.78 times the natural undamped frequency, find the amplitude of forced vibrations and the phase difference with respect to the disturbing force.

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 (10)
3. If the ship is rolling and at a certain instant has an angular velocity of 0.03 rad/s clockwise when looking fromstern.

Q3.a A steam engine 200 mm bore and 300 mm stroke has a connecting rod 625 mm long. The mass of the reciprocating parts is 15 kg and the speed is 250 r.p.m. When the crank is at 30° to the inner dead centre and moving outwards, the difference in steam pressures is 840 kN/m^2. If the crank pin radius is 30 mm determine: 1. the force on the crankshaft bearing; and 2. the torque acting on the crank shaft. (10)

Q3.b The disc of a torsional pendulum has a moment of inertia of 600 kg-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 position for successive cycles are 9°, 6° and 4°. Determine (a) logarithmic decrement (b) damping torque at unit velocity, and(c) the periodic time of vibration. (10)
Assume for the brass shaft, G = 4.4 x 10^{10} N/m^2.

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)

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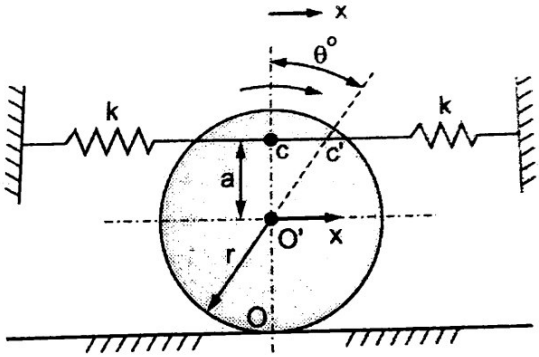
Q4.b Determine the natural frequency of the system shown in Fig below. Assume the cylinder rolls on the surface without slipping. Consider the mass of cylinder as M (10)



Q5.a. Four masses A, B, C and D revolve at equal radii and are equally spaced along a shaft. The mass B is 7 kg and the radii of C and D make angles of 90° and 240° respectively with the radius of B. Find the magnitude of the masses A, C and D and the angular position of A so that the system may be completely balanced. (10)

Q5.b A machine of mass one tonne is acted upon by an external force of 2450 N at a frequency of 1500 rpm. To reduce the effects of vibration, isolator of rubber having a static deflection of 2 mm under the machine load and an estimated damping factor 0.2 are used. Determine: (a) the force transmitted to the foundation, (b) the amplitude of vibration of machine(c) the phase lag. (10)

Q6.a A vehicle of mass 490 kg and total spring constant of its suspension system is 60 x 10^3 N/m. The profile of the road may be approximated to a line curve of amplitude 4.0 cm and wavelength of 4.0 metres. Determine :(a) the critical speed of the vehicle (8)
(b) the amplitude of the steady state motion of the mass when the vehicle is driven at critical speed and the damping factor is 0.5; and
(c) The amplitude of the steady state motion of mass when the vehicle is driven at 57 km/hr and the damping factor same as in (b).

Q6.b Show that the transmissibility ratio is 1 at a frequency ratio of 2 (5)

Q6.c A vibrometer having a natural frequency of 4 rad/sec and $\xi = 0.2$ is attached to a structure that performs a harmonic motion. If the difference between the maximum and the minimum recorded values is 8 mm, find the amplitude of motion of the vibrating structure with its frequency is 40 rad/s. (7)

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