B.E. Part III 6''' Semester Examination 2010

Subject: Dynamics of Machines and Vibration | Code No. AM 601

Branch: Mechanical Engineering

Time: 3 hrs. | Full Marks: 70

Assume reasonable data wherever necessary

FIRST HALF

ANSWER ALL THREE QUESTIONS

1. Figure 1 shows two Identical pendulums (of length / and mass m) connected by a spring of stiffness fc. The points of attachment of the spring Is at a distance * from the hinge points. The spring Is undeformed when both the pendulums are vertical. Assuming small oscillations, obtain the two natural frequencies and the corresponding normal modes with 0, and *0,* as the coordinates. *r ij*

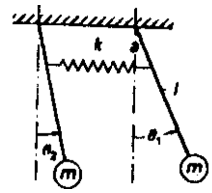

Fig. 1

OR

1. Figure 2 shows a single degree-of-freedom system with Coulomb damping. The mass Is excited by a harmonic force *F cos tot*. Slip across the damper takes place when the friction force reaches the value *f.* Determine the approximate steady-state amplitude by using the concept of equivalent viscous damping. Discuss the effect of approximation. (10+2)

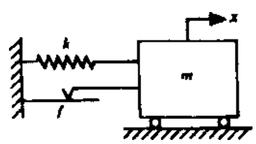

Fig. 2

2. The hinge point of a simple pendulum oscillates horizontally with amplitude *X* and a, frequency *a>* as shown in Fig. 3. Assuming the amplitude of oscillation to be small, derive the equation of motion and find out the stead-state amplitude of angular oscillation of the pendulum when (I) *a* = , (II) d› = 3(g//)"'.

In case (II) which point of the pendulum rod does not move during the stead-state motion? (6+2+2+1)

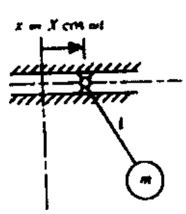

Fig. 3

SB

2 One end of a uniform bar of length / la fixed to a rigid wall, whereas the other end is resting on against an elastic pad of negligible mass but with stiffness * (See Fig. 4). Determine the frequency equation for the longitudinal oscillation of the bar. The Young's modulus and density of the bar material are *E* and *p,* respectively. t''*

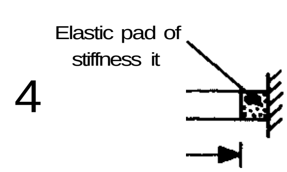

Fig. 4

3. Derive the equation of motion for the mass ***m*** in Fig. 5. Also obtain the steady-state amplitude of motion in terms of the system and excitation parameters. (12)

J ±

m

Fig. 5

OR

3. Using Rayleigh's principle, determine approximately the two natural frequencies and the corresponding mode shapes for the double pendulum shown in Flg.6 . (12)

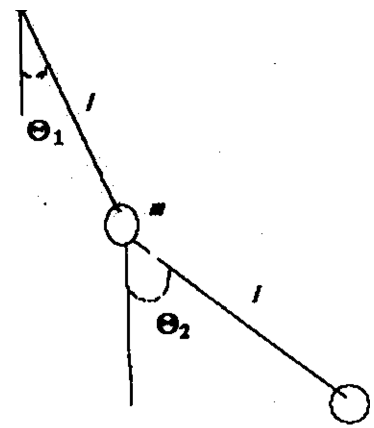

Fig. 6

SECOND HALF

QUESTION NO. 4 COMPULSORY AND ANY TWO FROM THE REST

4. Determine the natural frequency of vertical oscillation of the mass ***m,*** shown in Fig. 7 The mass of the pulley is neglected. (9)

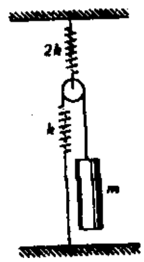

Fig. 7

OR

4. Figure 8 shows an SDF system where a massless rigid rod *OA* is hinged at *O* and carries a maas m at its other end *A.* A spring and a dashpot are attached to the bar vertically as shown. Assuming small oscillation, determine the critical damping coefficient. (9)

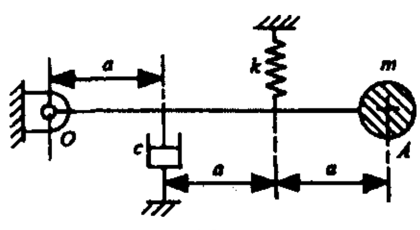

Fig. 8

5.

(a) What do you understand by primary and secondary unbalance in reciprocating engine? (4)

(b) The firing order of a six-cylinder vertical four-stroke in-line engine is 1-4-2-6-3-5. The piston stroke is 80 mm and the length of each connecting rod is 180 mm. The pitch distances between the cylinder centre lines are 80 mm, 80 mm, 120mm, 80 mm and 80 mm respectively. The reciprocating mass per cylinder is 1.2 kg and the engine speed is 2400 rpm. Determine the out of balance primary and secondary forces and couples on the engine taking a plane midway between the cylinder 3 and 4 as the reference plane. (9)

6.

(a) What do you mean by gyroscopic couple? Derive a relation for its magnitude. (4)

(b) Each road wheel of a motor cycle is of 600 mm diameter and has a moment of inertia of 1 .lkg.m^3. The motorcycle and the rider together weigh 220 kg and the combined centre of mass is 620 mm above the ground level when the motorcycle is upright. The moment of inertia of the rotating parts of the engine is 0.18 kg.m^2. The engine rotates at 4.5 times the speed of road wheels in the same sense. Find the angle of heel necessary when the motorcycle is taking a turn of 35 m radius at a speed of 72 km/h. (9)

7.

(a) The cranks of a three-cylinder single-acting engine are set equally at 120°. The engine speed is 540 rpm. The turning-moment diagram for each cylinder is a triangle for the power stroke with a maximum torque of 100 Nm at 60° after dead-centre of the corresponding crank. On the return stroke, the torque is sensibly zero. Determine

(i) the power developed

(ii) the coefficient of fluctuation of speed if the flywheel has a mass of 7.5 kg with a radius of gyration of 65 mm.

(iii) the coefficient of fluctuation of energy

(iv) the maximum angular acceleration of the flywheel. (6)

(b) A slider crank mechanism, shown in Fig.9 is instantaneously stationary. A moment M is applied on the crank OA and the crank starts with an angular acceleration or = 100 rad/s^2. The connecting rod is a uniform rod of 30 kg mass and 50 cm length. The crank radius is 25 cm. The mass of the slider is 20 kg. Determine (i) the acceleration of the slider and (ii) the direction and magnitude of the pin force at B. Neglect gravity and friction. (7)

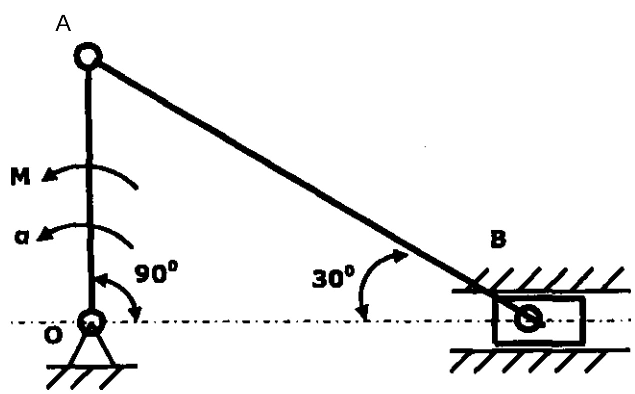

Fig.9