PMM/KS/15/7085/7137

Faculty of Engineering & Technology

Sixth Semester B.E. (Mechanical)/PE (C.B.S.)

Examination

DYNAMICS OF MACHINES

Time—Three Hours] [Maximum Marks—80

1. (a) State and explain D'Alembert principle. 6

(b) What is Gyroscope ? Derive an expression for Gyroscopic couple. 7

OR

2. A turbine rotor of a ship having a mass of 200 kg rotates at 2000 rpm and its radius of gyration is 0.30 m. If the rotation of the rotor is clockwise looking from the aft, determine the gyroscopic couple set by the rotor when :

(i) Ship takes a left turn at a radius of 300 meters at a speed of 30 km/hr.

(ii) Ship pitches with the bow rising at an angular velocity of 1 rad/sec and

(iii) Ship rolls at an angular velocity of 0.1 rad/sec.

Also state the effects of gyroscopic couple in all above cases. 13

3. (a) State and explain the conditions of static equilibrium for :

(i) Two force member

(ii) Three force member. 2

(b) How dynamic forces are developed in the mechanisms ? How they affect on the performance of mechanism ? 3

(c) For the link shown in Fig. Q. 3 (c) determine the inertia force and inertia torque. Locate the centre of percussion of the link

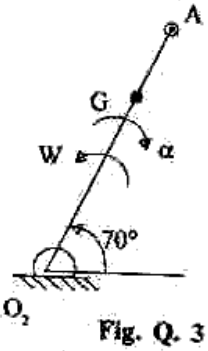

Fig. Q. 3 (c)

$O_2A = 400$ mm

$O_2G = 250$ mm

$W = 20$ rad/s

$\alpha = 150$ rad/s^2

$m = 3$ kg

$I = 0.160$ kgm^2 8

OR

4. A cam and follower mechanism has a cam machined so that it will move the follower to the right through a distance of 40 mm with parabolic motion in 120° of cam rotation, dwell for 30°, then return with parabolic motion to the starting position in the remaining cam angle. The spring rate is 5 kN/m, and the mechanism is assembled with 35 N preload. The follower mass is 18 kg.

(i) At what speed would jump begin ?

(ii) Without computing numerical values, sketch approximate graphs of the displacement motion, the acceleration and cam contact force, all versus cam angle for entire cycle of events from $\theta = 0°$ to $\theta = 360°$ of cam rotation. On this graph show where jump or left off is most likely to begin. 13

5. A rotating shaft carries four masses A, B, C and D which are radially attached to it. The mass centres are 30 mm, 38 mm, 40 mm and 35 mm respectively from the axis of rotation. The masses A, C and D are 7.5 kg, 5 kg and 4 kg respectively. The axial distance between the planes of rotation of A and B is 400 mm

and between B and C is 500 mm. The masses A and C are at right angles to each other. Find for complete balance,

(i) the angles between the masses B and D from mass A.

(ii) the axial distance between the planes of rotation of C and D.

(iii) the magnitude of mass B. 13

OR

6. (a) Can you balance the reciprocating masses completely ? If yes how ? If not why ? Explain. 4

(b) The following data refers to a two cylinder locomotive with crank at 90° :

Reciprocating mass per cylinder = 400 kg.

Crank radius = 350 mm

Driving wheel diameter = 2.1 m

Distance between cylinder centre lines = 600 mm

Distance between driving wheel central planes = 1.5 m

Determine :

(i) The fraction of reciprocating masses to be

balanced if the hammer blow is not to exceed 50 kN at 120 kmph.

(ii) Variation in tractive effort.

(iii) Swaying couple. 9

7. In a single acting four stroke engine, the work done by the gases during the expansion stroke is three times the work done during the compression stroke. The work done during suction and exhaust stroke is negligible. The engine develops 14 kW at 280 rpm. The fluctuation of speed is limited to 1.5% of mean speed on either side. The turning moment diagram during compression and the expansion strokes may be assumed to be triangular in shape. Determine the inertia of the flywheel. 13

OR

8. (a) What is function of Governor ? How is it differ from flywheel ? 4

(b) A porter governor has equal arms each 250 mm long and pivoted on the axis of rotation. Each ball has a mass of 5 kg and the mass of the central load on the sleeve is 25 kg. The radius of rotation of the ball is 150 mm when the governor begins to lift and 200 mm when the governor is

at maximum speed. Find the range of speed, sleeve lift, governor effort and power of the governor in the following cases :

(i) when the friction at the sleeve is neglected and

(ii) when the friction at sleeve is equivalent to 10 N. 9

9. (a) Determine the natural frequency of system shown in Fig. Q. 9 (a). 7

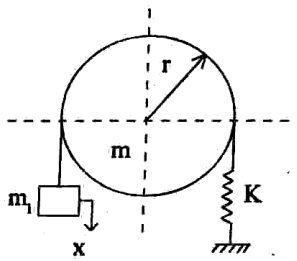

Fig. Q. 9 (a)

(b) A mass of 1 kg is to be supported on a spring having constant of K = 9800 N/m. The damping coefficient is 4.9 N-s/m. Determine the damped natural frequency of the system. Find also the logarithmic decrement and amplitude of vibration after 8th cycle if the initial displacement is 0.4 cm. 7

OR

10. (a) A machine of mass 1000 kg rests on 4 springs each having stiffness of 3.5×10^6 N/m. The damping factor of dashpot is 0.2. The machine runs at 2000 rpm, under these operating conditions the machine is found to deflect by 0.06 mm. Find the magnification factor and force transmitted through each mounting. 8

(b) Explain in brief (any **three**) :

(i) Critical speed of shaft

(ii) Transmissibility

(iii) Logarithmic decrement

(iv) Vibration isolation. 6

11. Derive an expression for natural frequencies and amplitude ratios for the system shown in Fig. Q. 11. For the small displacement in the plane of paper. The pendulum rod is stiff and is pivoted at print O.

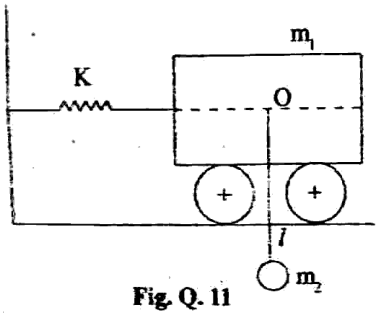

Fig. Q. 11 14

OR

12. Determine the natural frequencies of torsional oscillation for the following system. The system is a reciprocating I.C. engine coupled to a centrifugal pump through a pair of gears. The shaft from the flywheel of the engine to the gear wheel is of 60 mm diameter and 950 mm length. The shaft from the pinion to the pump is of 40 mm diameter and 300 mm length. The engine speed is $\frac{1^{th}}{4}$ of the pump speed :

Moment of inertia of the flywheel = 800 kg-m^2

Moment of inertia of the gear wheel = 15 kg-m^2

Moment of inertia of the pinion = 4 kg-m^2

Moment of inertia of the pump = 17 kg-m^2

Modulus of rigidity for the shaft material is 84 GN/m^2 14