B.E. (Mechanical Engineering / Power Engineering) Sixth Semester (C.B.S.)

Dynamics of Machines

P. Pages : 4

Time : Three Hours

TKN/KS/16/7486/7512

Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Illustrate your answers whenever necessary with the help of neat sketches.
11. Use of non programmable calculator is permitted.

1. a) What are dynamic forces ? How dynamic forces are developed in mechanical system ? State & explain D'Alemberts principle. **4**

b) Explain with a sketch of rotating disc, how gyroscopic effect occurs? What is angular momentum ? Derive relation for gyroscopic couple. **5**

c) A flywheel having a mass of 20kg and a radius of gyration of 300mm is given a spin of 500rpm about its axis which is horizontal. The flywheel is suspended at a point that is 250mm from the plane of rotation of the flywheel. Find the rate of precession of the wheel. **4**

2. The rotor of a marine turbine has a moment of inertia of 750 kgm^2 and rotates at 3000 rpm clockwise when viewed from att. If the ship pitches with angular simple harmonic motion having a periodic time of 16 seconds and an amplitude of 0.1 radium find the

i) Maximum angular velocity of the rotor axis. **3**

ii) Maximum value of the gyroscopic couple. **3**

iii) Gyroscopic effect as the bow dips. **7**

3. For the four bar mechanism shown in fig 3 determine the torque required to overcome the inertia forces of link AB when the crank is at 60°. **14**

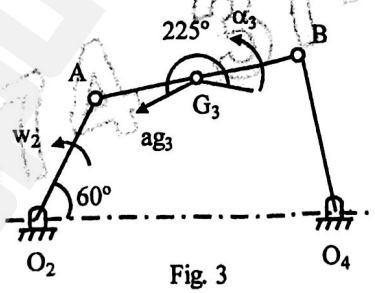

Fig. 3

O_2A = 400 mm
AB = 900 mm
O_4B = 800 mm
O_2O_4 = 1200 mm
AG_3 = 450 mm
m_3 = 3 kg
I_3 = 0.2025 kgm^2

Mass of Link AB is 3kg and its moment of inertia in 0.2025 kgm^2. The acceleration of the CG of link AB in the direction shown is 154 m/s^2 and its angular acceleration as shown in 120 m/s^2.

P.T.O

4. a) What is dynamically equivalent link ? Explain what is centre of percussion and how it is useful in sports applications like cricket bat or baseball bat design ? 4

b) What is jump off speed in cam follower mechanism ? A circular disc cam with diameter of 80mm with its centre displaced at 30mm from the camshaft is used with a flat plate follower. The follower in radial with mass 2.5kg and pressed down words with a spring of stiffness 4N/mm. In the lowest position the spring force in 50N. 10

Derive an expression for the acceleration of the follower as a function of cam rotation from the lowest position of the follower. The displacement is given by $x = e - e\cos\theta$ where e in the distance between centre of circular disc and camshaft. Find the speed at which the follower begins to lift from the cam surface.

5. a) What is static balancing ? What is dynamic balancing ? Statically balanced system is dynamically balanced also true or false ? Explain. 4

b) A circular disc mounted on the centre of 500mm long shaft carries three attached masses of 4kg, 3kg and 2.5kg at radial distances of 75mm, 85mm and 50mm and at the angular positions of 45°, 135° and 240° respectively. The angular positions are measured counterclockwise from the reference line along the x-axis. The shaft with the disc is mounted on two bearings at the ends and rotates at 300 rpm. This disc is to be balanced by putting a counter mass of 4kg. Determine the bearing reactions before and after balancing. Also find the radial distance and angular positon of the counter mass to be placed on the same rotating disc. 9

6. a) What are primary and secondary forces in reciprocating engine mechanism ? 2

b) What is fixing order of inline multi cylinder engine ? What is its significance in balancing of multi cylinder engines ? 2

c) The firing order of a six cylinder vertical four stroke inline engine is 142635. The Piston stroke is 80mm and the length of each connecting rod is 180mm. The pitch distances between the cylinder centre lines are 80mm, 80mm, 120mm, 80mm and 80mm respectively. The reciprocating mass per cylinder is 1.2kg and the engine speed is 2400 rpm. Determine the outof balance primary & secondary forces and couples on the engine taking a plane midway between the cylinders 3 and 4 as the reference plane. 9

7. The equation of turning moment for a three-crank engine is. 13

$T_C = 25.0 - 7.5 \text{ Sin } 3\theta$ kNm Where θ is the crank angle measured from inner dead centre. The resisting torque exerted by the driven machine is given by $T_r = 25.0 + 3.6\sin\theta$ kNm the moment of Inertia of the flywheel is 360 kg m^2 and the mean engine speed is 450rpm. Calculate

a) The power of the engine.
b) The maximum fluctuation of energy per cycle, and
c) The coefficient of fluctuation of speed.

8. a) Explain the following terms with reference to governor. 6
i) Sensitiveness of a governor.
ii) Hunting.
iii) Stability.

b) A porter governor has equal arms. Each arm is 250mm long and is ported on the axis of rotation. The mass of each ball is 5kg and the sleeve is 20kg. The sleeve begins to rise when the radius of rotation of the balls is 150mm and reaches the top when it is 200mm. Determine the range of speed, lift of the sleeve and sensitiveness of the governor. 7

9. a) Define following terms with reference to vibrations. 3

i) Amplitude. ii) Natural frequency.

iii) Degree of freedom. iv) Damping.

v) Resonance. vi) SHM.

b) A spring mass system has a natural frequency of 12Hz. When the spring constant is reduced by 800N/m the frequency is changed by 50%. Determine the mass and spring constant of the original system. 5

c) A load W is vertically suspended on two springs of constants K_1 & K_2 as shown in fig 9 C. Determine the resultant spring constant and the frequency of the load. 6

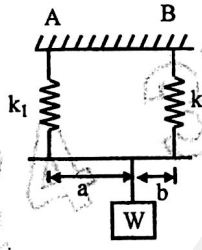

Fig. 9 (c)

10. a) In a spring mass system the mass of 10kg makes 40 oscillations in 20 seconds without damper. With damper, the amplitude decreases to 0.20 of the original value after 5 oscillations find out. 8

a) Stiffness of the spring. b) Logarithmic decrement.

c) Damping factor. d) Damping coefficient.

b) An electric motor of mass 30kg is running at 500rpm. The motor is supported on a spring of 7kN/m and a dashpot which offers a resistance of 600 N at 0.25 m/s. The unbalance of the rotor is equivalent to a mass of 0.8 Kg located 5cm from the axis of rotation. Knowing that the motor is constrained to move vertically, determine. 6

i) The damping factor.

ii) Amplitude of vibration and phase angle, and

iii) Resonant speed & resonant amplitude.

11. A steel shaft of diameter 10cm is carrying three masses 2.5kg, 3.75kg and 7kg respectively as shown in fig. 11 the distances between the rotors are 0.7m. Determine the natural frequencies of torsional vibrations. The radii of gyration of three rotors are 0.2, 0.3 and 0.4m respectively. 13

Take $G = 9\times10^8\ N/m^2$.

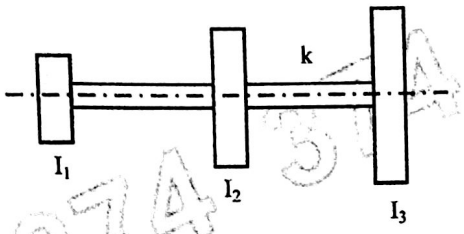

Fig. 11

12. a) Write short notes on 6

i) Vibration Absorber. ii) FFT Analyzer.

b) Derive the relation for natural frequency of vibrations of two rotors system. 7

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