T 8249

B./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2006.

Fourth Semester

Mechatronics Engineering

ME 1301 – DYNAMICS OF MACHINERY

(Common to B.E (Part-time) – Third Semester – R 2005)

(Regulation – 2004)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the requirements of an equivalent dynamical system?

2. What is the function of a flywheel? How does it differ from that of a governor?

3. Why is balancing of rotating parts necessary for high speed engines?

4. Discuss the effect of partial balancing of reciprocating parts of two cylinder locomotives.

5. A vibrating system consist of a mass of 200 kg, a spring of stiffness 80 N/mm and a damper with damping co-efficient of 800 N/m/s. Determine the frequency of vibration of the system.

6. What do you understand by transmissibility?

7. Explain the term 'critical speed' of a shaft.

8. Discuss the response caused by the unbalanced force.

9. State the different types of governors.

10. The turbine rotor of a ship has a mass of 8 tonnes and a radius of gyration 0.6 m. It rotates at 1800 rpm. Clockwise, when looking from the stem. Determine the gyroscopic couple, if the ship travels at 100 km/hr and steers to the left in a curve of 75 m radius.

PART B — (5 × 16 = 80 marks)

11. (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 rpm. On the expansion stroke with a crank 20° from top dead center, the gas pressure is 700 kN/m^2. Determine.

(i) Net force on the piston. (6)

(ii) Resultant load on the gudgeon pin. (3)

(iii) Thrust on the cylinder walls, and. (2)

(iv) Speed above which, other things remaining same, the gudgeon pin load would be reversed in direction. (5)

Or

(b) A machine requires a torque of $(500 + 50 \sin \theta)$ kg-m to drive it, where θ is the angle of rotation of shaft measured from certain datum. The machine is directly coupled to an engine which produces a torque of $(500 + 60 \sin 2\theta)$kg-m. The flywheel and other rotating parts attached to the engine weigh 5000 kg and have a radius of gyration of 300 mm. If the mean speed is 1500 rpm find.

(i) The fluctuation of energy. (8)

(ii) The percentage of fluctuation of speed. (2)

(iii) The maximum and minimum angular acceleration of the flywheel and corresponding shaft positions. (6)

12. (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 80mm. 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.

(i) The magnitude of the masses at A and D. (12)

(ii) The distance between planes A and D. (2)

(iii) And the angular position of the mass at D. (2)

Or

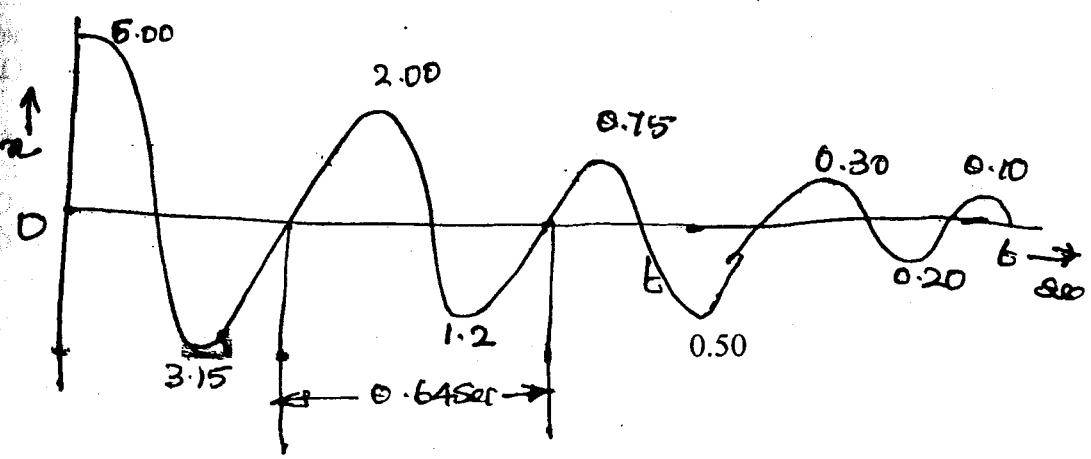
An inside cylinder locomotive has its cylinder center lines 0.70 m apart and has a stroke of 0.60 m. The rotating masses per cylinder are equivalent to 150 kg at the crank pin and the reciprocating masses per cylinder to 180 kg. The wheel center lines are 1.5 m apart. The cranks are at right angles.

The whole of the rotating and 2/3 of the reciprocating masses are to be balanced by masses placed at a radius of 0.6 m. Find the magnitude and direction of the balancing masses.

Find the fluctuation in rail pressure under one wheel, variation of tractive effort and the magnitude of Swaying Couple at a Crank Speed of 300 rpm.

(a) (i) A Vibratory system in a vehicle is to be designed with the following parameters k = 100 N/m, C = 2 N-sec/m m = 1 Kg. Calculate the decrease of amplitude from its starting value after 3 complete oscillations and the frequency of oscillations.

(ii) Free Vibration record of 1000 kg machine mounted on an isolator is shown in Figure.



Identify the type of isolator and its characteristics ie the spring.

Or

(b) A disc of mass 4 kg is mounted midway between bearings which may be assumed to be simple supports. The bearing span is 500 mm. The shaft is of 10 mm diameter and is horizontal. The center of gravity of the disc is displaced 2 mm from the geometric center. The equivalent viscous damping at the center of the disc-shaft may be assumed as 50 N-sec/m. If the shaft rotates at 250 rpm, determine the maximum stress in the shaft. Also find the power required to drive the shaft, at this speed $E = 1.96 \times 10^{11}$ N/m^2 .

14. (a) A vibratory body of mass 150 kg supported on springs of total stiffness 1050 kN/m has a rotating unbalance of 525 N at a speed of 6000 rpm. If the damping factor is 0.3 determine.

(i) The amplitude caused by the unbalance and its phase angle. (10)

(ii) The transmissibility and (4)

(iii) The actual force transmitted and its phase angle. (2)

Or

(b) A single – cylinder engine of total mass 200 kg is to be mounted on an elastic support which permits vibratory movement in vertical direction only. The mass of piston is 3.5 kg and has a vertical reciprocating motion which may be assumed simple harmonic with a stroke of 150 mm. It is desired that the maximum vibratory force transmitted through the elastic support to the foundation shall be 600 N when the engine speed is 800 rpm. and less than this at all higher speeds.

(i) Find the necessary stiffness of the elastic support and the amplitude of vibration at 800 rpm. and (6)

(ii) If the engine speed is reduced below 800 rpm, at what speed will the transmitted force again becomes 600 N. (10)

15. (a) The arms of a porter governor are 300 mm long. The upper arms are pivoted on the axis of rotation. The lower arms are attached to a sleeve at a distance of 40 mm from the axis of rotation. The mass of the load on the sleeve is 70 kg and the mass of each ball b 10 kg. Determine the equilibrium speed when the radius of rotation of the balls is 200 mm. If the friction is equivalent to a load of 20 N at the sleeve, what will be the range of speed for this position.

Or

(b) An automobile is traversing along a curved, track of 200 m mean radius. Each of the four road wheels has a mass of 80 kg with a radius of gyration of 0.4 m. The rotating parts of the engine have a mass moment of inertia of 10 kg-m^2. The crank shaft rotates in the same direction as the road wheels. The gear ratio of the engine to the back wheels is 5:1. The vehicle has a mass of 3000 kg and its C.G is 0.5 m above the road level. The width of track of vehicle is 1.5 m. Calculate the limiting speed of the vehicle around the curve for all wheels to maintain contact with the road surface.
