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Question Paper Code : 21568

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Fifth Semester

Mechanical Engineering

ME 2302/ME 52/ME 1301/10122 ME 503 — DYNAMICS OF MACHINERY

(Regulation 2008/2010)

(Common to PTME 2302 – Dynamics of Machinery for B.E. (Part-Time) Fourth Semester Mechanical Engineering – Regulation 2009)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Distinguish between static force and inertia force.

2. What is engine shaking force?

3. Write the expressions for primary and secondary unbalanced forces of reciprocating masses.

4. Unbalanced effects of shafts in high speed machines are to be closely looked into. Why?

5. Determine the natural frequency of mass of 10 kg suspended at the bottom of two springs (of stiffness: 5N/mm and 8 N/mm) in series.

6. Give the limit beyond which damping is detrimental. Why?

7. Define transmissibility.

8. Show that for effective isolation of vibration ,frequency ratio $r > \sqrt{2}$.

9. What is meant by isochronous condition in governors?

10. What will be the effect of the gyroscopic couple on a disc fixed at a certain angle to a rotating shaft?

PART B — (5 × 16 = 80 marks)

11. (a) A shaft fitted with a flywheel rotates at 250r.p.m and drives a machine. The torque of machine varies in a cyclic manner over a period of 3 revolutions. The torque rises from 750N/m to 300 N/m uniformly during 1/2 revolution and remains constant for the following revolution. It then falls uniformly to 750 N-m during the next 1/2 revolution and remains constant for one revolution, the cycle being repeated thereafter.

Determine the power required to drive the machine and percentage fluctuation in speed, if the driving torque applied to the shaft is constant and the mass of the flywheel is 500kg with radius of gyration of 600 mm. (16)

Or

(b) A horizontal steam engine running at 240 r.p.m has a bore of 300 mm and stroke 600mm. The connecting rod is 1.25m long and the mass of reciprocating parts is 60 kg. When the crank is 60° past its inner dead centre, the steam pressure on the cover side of the piston is 1.125 N/mm^2 while that on the crank side is 0.125 N/mm^2. Neglecting the area of the piston rod, determine:

(i) the force on the piston rod, and (8)

(ii) the turning moment on the crankshaft. (8)

12. (a) A shaft has three eccentrics, each 75 mm diameter and 25 mm thick, machined in one piece with the shaft. The central planes of the eccentric are 60 mm Apart. The distance of the centres from the axis of rotation are 12 mm, 18mm and 12 mm and their angular positions are 120° apart. The density of metal is 7000 kg/m^3. Find the amount of out-of-balance force and couple at 600 r.p.m. If the shaft is balanced by adding two masses at a radius of 75 mm and at a distance of 100mm from the central plane of the middle eccentric, find the amount of the masses and their angular positions. (16)

Or

(b) The three cranks of a three cylinder locomotive are all on the same axle and are set at 120°. The pitch of the cylinders is 1 metre and the stroke of each piston is 0.6 m. The reciprocating masses are 300 kg for inside cylinder and 260 kg for each outside cylinder and the planes of rotation of the balance masses are 0.8m from the inside crank. If 40% of the reciprocating parts are to be balanced, find:

(i) The magnitude and the position of the balancing masses required at a radius of 0.6m; and (8)

(ii) The hammer blow per wheel when the axle makes 6 r.p.s. (8)

13. (a) A vertical shaft of 5mm diameter is 200mm long and is supported in long bearings at its ends. A disc of mass 50 kg is attached to the centre of the shaft. Neglecting any increase in stiffness due to the attachment of the disc to the shaft, find the critical speed of rotation and the maximum bending stress when the shaft is rotating at 75% of the critical speed. The centre of the disc is 0.25 mm from the geometric axis of the shaft. $E = 200\ GN/m^2$. (16)

Or

(b) A machine of mass 75 kg is mounted on springs and is fitted with a dashpot to damp out vibrations. There are three springs each of stiffness 10 N/mm and it is found that the amplitude of vibration diminishes from 38.4mm to 6.4mm in two complete oscillations. Assuming that the damping force varies as the velocity, determine:

(i) The resistance of the dashpot at unit velocity; (6)

(ii) The ratio of the frequency of the damped vibration to the frequency of the undamped vibration; and (6)

(iii) The periodic time of the damped vibration. (4)

14. (a) A mass of 10 kg is suspended from one end of a helical spring, the other end being fixed. The stiffness of the spring is 10N/mm. The viscous damping causes the amplitude to decrease to one-tenth of the initial value in four complete oscillations. If a periodic force of $150\cos 50t$ N is applied at the mass in the vertical direction, find the amplitude of the forced vibrations. What is its value of resonance? (16)

Or

(b) The mass of an electric motor is 120 kg and it runs at 1500 r.p.m. The armature mass is 35 kg and its C.G lies 0.5mm from the axis of rotation. The motor is mounted on five springs of negligible damping so that the force transmitted is one-eleventh of the impressed force. Assume that the mass of the motor is equally distributed among the five springs.

Determine:

(i) Stiffness of each spring (6)

(ii) Dynamic force transmitted to the base at the operating speed (6)

(iii) Natural frequency of the system. (4)

15. (a) A Proell governor has equal arms of length 300 mm. The upper and lower ends of the arms are pivoted on the axis of the governor. The extension arms of the lower links are each 80 mm long and parallel to the axis when the radii of rotation of the balls are 150 mm and 200 mm. The mass of each ball is 10kg and the mass of the central load is 100kg. Determine the range of speed of the governor. (16)

Or

(b) The turbine rotor of a ship has a mass of 3500kg. It has a radius of gyration of 0.45mm and a speed of 3000 r.p.m clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship:

(i) When the ship is steering to the left on a curve of 100m radius at a speed of 36km/h.

(ii) When the ship is pitching in a simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12 degrees. (16)