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Question Paper Code : 40835

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Fourth/Fifth Semester

Mechanical Engineering

ME 8594 — DYNAMICS OF MACHINES

(Common to Mechanical Engineering (Sandwich)/Mechatronics Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. List the two conditions for static equilibrium.

2. State D'Alembert's principle.

3. Mention any three factors that contribute to unbalance in a rotating system.

4. When is a system said to be completely balanced?

5. What do you understand by degrees of freedom?

6. List the various types of dampers.

7. Calculate the deflection of the spring of stiffness 35 kN to which a body of mass 35 kg is suspended.

8. Define transmissibility.

9. What do you mean by sensitiveness of governor?

10. What is gyroscopic torque?

PART B — (5 × 13 = 65 Marks)

11. (a) A vertical double acting steam engine has a cylinder 300 mm in diameter, 450 mm stroke and operates at 200 rpm. The mass of reciprocating parts is 225 kg, the piston rod is 50 mm in diameter and the connecting rod is 1 metre long. When crank has turned through 125° from the top dead centre the steam pressure above the piston is 30 kN/m² and below the piston is 2 kN/m². Calculate the tangential force on the crank pin and effective turning moment on the crankshaft. (13)

Or

(b) The turning moment diagram for engine consist of two isosceles triangles with maximum height of each triangle representing turning moment equal to 1000 Nm, while the base of the triangle is from $\theta = 0°$ to 180° $\theta = 180°$ to 360°. If the engine runs at 200 rpm and if the total fluctuation of speed is not to exceed 2.8%, calculate the indicated horsepower of the engine and moment of inertia of the flywheel. (13)

12. (a) Shaft has eccentrics each 7.5 cm diameter and 2.5 cm thick machined in one piece with the shaft. The central planes of the eccentrics are 6 cm apart. The distance of the centres from the axis of rotation are 1.2 cm, 1.9 cm and 1.2 cm with angular positions 120° apart and the metal weights 0.007 kg/m³. Calculate the out of balance force and couple at 600 rpm. If the shaft is balanced by adding two weights of radius 7.5 cm and at a distance of 10 cm from the central plane of the middle eccentrics, find the weights to be added and their angular positions. (13)

Or

(b) An air compressor has four inline cylinders at 90° intervals. The crank radius is 140 mm, while the connecting rod is 560 mm long for each cylinder. The mass of reciprocating parts is 20 kg for each cylinder and speed of rotation is 600 rpm and the cylinders are 300 mm apart. Prove that there is nil out of balance primary and secondary forces. Determine the corresponding magnitude of primary and secondary couples. (13)

13. (a) A vibration system consists of a mass 60 kg, a spring of stiffness 30 kN/m and a damper. The damping provided is only 20% of the critical value. Determine (13)

(i) the damping factor,

(ii) critical damping coefficient,

(iii) natural frequency of the damped vibration

(iv) log logarithm decrement and

(v) ratio of the two consecutive amplitudes.

Or

(b) The flywheel of an engine driving a Dynamo has a mass of 180 kg and radius of gyration of 25 mm. The shaft at the flywheel end has an effective length of 250 mm and 50 mm diameter. The mass of the armature is 120 kg and its radius of gyration is 22.5 mm. The Dynamo shaft has 50 mm diameter and 200 mm effective length. Calculate the position of the node and frequency of torsional oscillation. Assume $C = 83$ kM/mm^2. (13)

14. (a) A motor of weight 25 kg is mounted on a rubber pad which deflects by 1 mm due to motor weight. The rotor weighs 5 kg and has an eccentricity of 0.1 mm and rotates at 1500 rpm. Find the amplitude of vibration of the motor and the force transmitted to the foundation under no damping and a damping factor of 0.1 condition. (13)

Or

(b) Determine the displacement amplitude of 1.5 Ton car moving with velocity of 100 kmph as it passes over a rough road which has a sinusoidal surface with amplitude of 75 mm and wavelength of 5 mm. The suspension system has spring constant of 500 N/mm and damping ratio of 0.5. (13)

15. (a) A porter governor has all four arms 300 mm long. The upper arms are pivoted on the axis of rotation. Each ball has a mass of 4 kg and mass of central load on the sleeve is 50 kg. The radius of rotation of the balls is 200 mm if the lower arms are attached to the sleeve at 35 mm from the axis, determine the equilibrium speed of the governor. (13)

Or

(b) The turbine rotor of a ship has a mass of 2000 kg and rotates at a speed of 3000 rpm clockwise when looking from a stern. The radius of gyration of the rotor is 0.5 m. Determine the gyroscope couple and its effect on the ship when the ship is steering to the right in a curve of 100 m radius at a speed of 29000 m/hr. Also, calculate the torque and its effect when the ship is pitching in Simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 50 seconds and the angular displacement between the two extreme positions of the pitching is 12°. Find the maximum acceleration during pitching motion. (13)

PART C — ($1 \times 15 = 15$ marks)

16. (a) Investigate the term involved in the equation of motion of one degree of freedom system as given by $5\ddot{x} + 3\dot{x} + 12x = 10 \sin \omega t$. (15)

Or

(b) Prove that the resultant unbalanced force is minimum, when half of the reciprocating masses are balanced by rotating masses i.e. when c = 1/2. (15)

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