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Question Paper Code : 50881

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

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 × 2 = 20 marks)

1. Differentiate between piston efforts and crank efforts.
2. Write the expression for Coefficient of Fluctuation of Speed.
3. What is the cause and effect of hammer blow in dynamics?
4. Mention the reason for selecting a multi-cylinder engine in comparison with a single-cylinder engine.
5. Find the damping factor of system with 7 kg mass, 50 N/cm stiffness, and damping coefficient of 0.36 Ns/cm.
6. Express the relation between frequency of undamped and damped vibration.
7. List down the types of forces that creates vibration.
8. What is meant by harmonic forcing?
9. Write any four difference between the governor and flywheel.
10. Define the effect of the gyroscopic couple on a 2-wheeler when taking a left turn.

PART B — (5 × 13 = 65 marks)

11. (a) The torque developed in a two-stroke engine is represented by $T=(1000+300 \sin 2\theta - 500 \cos 2\theta)$ N-m where θ is the angle turned by the crank from the IDC and the engine speed is 250 rpm. The mass of the flywheel is 400 kg and radius of gyration 400 mm. Determine, (i) the power developed, (ii) the total percentage fluctuation of speed, (iii) the angular acceleration of flywheel when the crank has rotated through an angle of 45° from the IDC and (iv) the maximum angular acceleration and retardation of the flywheel.

Or

(b) The length of the crank and connecting rod of a reciprocating engine are 300 mm and 1 m respectively. While the crank is rotating at 500 rpm and has turned 20° from the inner dead center, the difference of pressure between cover end and piston rod is 0.4 N/mm². If the mass of the reciprocating component is 150 Kg and a cylinder bore is 0.4 m. Calculate the inertia force, force on piston, and piston effort.

12. (a) Four masses M_1, M_2, M_3, and M_4 are 300 kg, 250 kg, 280 kg and 200 kg respectively. The corresponding radii of rotation of the M_1, M_2, M_3, and M_4 are 0.2 m, 0.15 m, 0.25 m, and 0.3 m respectively and the angle between successive masses are 45°, 75°, and 135°. Find the position and magnitude of balance mass required if its radius of rotation is 0.25m.

Or

(b) A, B, C, and D the four masses that are to be completely balanced, masses C and D makes angles of 90° and 195° respectively with B. The rotating masses have the following properties: $m_A = 25$ kg, $r_A = 150$ mm, $m_B = 40$ kg $r_B = 200$ mm, $m_C = 35$ kg, $r_C = 100$ mm, $r_D = 180$ mm, Planes B and C are 250 mm apart. Determine, (i) the mass of D, (ii) the angular position of A, and (iii) the position of planes A as well as D.

13. (a) A shaft of 120 mm diameter is supported by two bearings separated by 3 m. It holds three discs of mass 350 kg, 400 kg and 300 kg at 0.6 m, 1.5 m and 2 m from the left hand. Assuming mass of the shaft as 190 kg/m, determine critical speed of the shaft. Assume E = 211 GN/m².

Or

(b) In a vibration system, a suspended mass of 8 kg makes 30 oscillations in 18 seconds. The amplitude decreases in 18 seconds to 0.25 of the initial value after 5 oscillations. Determine (i) the spring stiffness, (ii) logarithmic decrement, (iii) damping factor, and (iv) Damping coefficient.

14. (a) A component of 60 Kg is supported by an elastic structure of total stiffness 20 kN/m. The Damping ratio of the whole system is 0.2. A simple harmonic distribution force 60 sin 10 t N acts at the component at a time of 't' seconds. Find the amplitude of the vibration and phase angle caused by the damping.

Or

(b) The barrel of a gun recoils against a spring on firing. At the end of the firing, a dashpot is engaged that allows the barrel to return to its original position in minimum time without oscillation. Gun barrel mass is 400 kg and initial velocity of recoils 1 m. Determine spring stiffness and critical damping coefficient of dashpot.

15. (a) (i) With an appropriate sketch explain the gyroscopic couple of the naval ship during pitching.

(ii) Explain the gyroscopic couple on a aeroplane with a neat sketch.

Or

(b) In a Porter governor, the length of each arm is 190 mm and is hinged at the axis of rotation. The mass of each ball is 7 kg and the load on the sleeve is 25 kg. The extreme radii of rotation are 85 mm and 130 mm. Plot a graph of the controlling force vs. radius of rotation and set off a speed scale along the ordinate corresponding to a radius of 160 mm.

PART C — (1 × 15 = 15 marks)

16. (a) The crank of radius 100 mm is connected to the connecting rod of 450 mm length. Derive the Velocity and Acceleration of piston as well as the Angular velocity and Angular acceleration of connecting rod when the crank rotating at 400 rpm has turned 30° from the IDC.

Or

(b) A steel shaft with Young's modulus 2×10^{11} N/m^2 and 100 mm in diameter is support in a bearing 4 m apart. The shaft carries three loads 50 kg at the centre, 65 kg at a distance 1.2 m from the left bearing, and 70 kg at 0.9 m from the right bearing. Using Dunkerley's method find the value of the critical speed.

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