Reg. No. : | | | | | | | | | | | |

J 3310

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2009.

Fourth Semester

Mechatronics Engineering

ME 1301 — DYNAMICS OF MACHINERY

(Regulation 2004)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State D-Alembert's principle.

2. What is the function of the flywheel?

3. Define tractive force.

4. What are In-line engines?

5. What are the types of free-vibrations?

6. What do you mean by amplitude reduction factor?

7. What is the natural frequency of torsional vibration for a shaft fixed at one end and carrying a rotor at the free end?

8. How many number of nodes will be there for a shaft carrying three rotors?

9. What is the function of a governor?

10. What are the terms used in a Naval ship?

PART B — (5 × 16 = 80 marks)

11. (a) The crank and connecting rod of a steam engine are 0.3 m and 1.5 m in length. The crank rotates at 180 rpm clockwise. Determine the velocity and acceleration of the piston when the crank is at 40 degrees from the inner dead center position. Also determine the position of the crank for zero acceleration of the piston.

Or

(b) A riveting machine is driven by a constant torque 3 kW motor. The moving parts including the flywheel are equivalent to 150 kg at 0.6 m radius. One riveting operation takes one second and absorbs 10000 N-m of energy. The speed of the flywheel is 300 rpm before riveting. Find the speed immediately after riveting. How many rivets can be closed per minute? 15

12. (a) Four masses m_1, m_2, m_3 and m_4 are 200 kg, 300 kg, 240 kg and 260 kg respectively. The corresponding radii of rotation are 0.2 m, 0.15 m, 0.25 m and 0.3 m respectively and the angles between successive masses are 45°, 75° and 135°. Find the position and magnitude both analytically as well as graphically, if its radius of rotation is 0.2 m.

Or

(b) Explain the partial balancing of unbalanced primary force in a reciprocating engine.

13. (a) A cantilever shaft 50 mm diameter and 300 mm long has a disc of mass 100 kg at its free end. The Young's modulus for the shaft material is 200 GN/m^2. Determine the frequency of longitudinal and transverse vibrations of the shaft.

Or

(b) A shaft 50 mm diameter and 3 metres long is simply supported at the ends and carries three loads of 1000 N, 1500 N and 750 N at 1 m, 2 m and 2.5 m from the left support. The Young's modulus for shaft material is 200 GN/m^2, find the frequency of transverse vibration.

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 10 N/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 $\cos 50\,t$ N is applied at the mass in the vertical direction, find the amplitude of the forced vibrations. What is its value of resonance?

Or

(b) The mass of an electric motor is 120 kg and it runs at 1500 rpm. The armature mass is 35 kg and its centre of gravity lies 0.5 mm 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. (8)

(ii) dynamic force transmitted to the base at the operating speed. (8)

15. (a) A Hartnell governor having a central sleeve spring and two right angled bell crank levers moves between 290 rpm and 310 rpm for a sleeve lift of 15 mm. The sleeve arms and the ball arms are 80 mm and 120 mm respectively. The levers are pivoted at 120 mm from the governor axis and mass of each ball is 2.5 kg. The ball arms are parallel to the governor axis at the lowest equilibrium speed. Determine

(i) loads on the spring at the lowest and highest equilibrium speeds and

(ii) stiffness of the spring.

Or

(b) The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45 m and a speed of 3000 rpm 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 100 m radius at a speed of 36 km/hr.

(ii) When the ship is pitching with bow falling with a maximum velocity? The period of pitching is 40 secs and angular displacement between two extreme positions of pitching is 12 degrees.
