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T 3349

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2008.

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. Define Inertia force.

2. What is coefficient of fluctuation of energy?

3. What is the firing order of six – cylinder engine? Is this engine fully balanced?

4. Determine the primary out-of-balance force for a single cylinder engine with a piston of mass 0.5 kg, connecting rod of 120 mm long and a crank radius of 50 mm when the speed of rotation is 2000 rpm.

5. A harmonic motion has a frequency of 10 Hz and its maximum velocity is 57 m/s. Determine its amplitude.

6. What are the benefits of having damping in a vibrating system?

7. What is the difference between free vibration and forced vibration?

8. Sketch a graph (for different values of damping factor) to show the variation of transmissibility ratio against frequency ratio.

9. What is the difference between centrifugal and inertia type governors?

10. What is the effect of gyroscopic couple on an aeroplane taking a turn?

PART B — (5 × 16 = 80 marks)

11. (a) The connecting rod of a vertical engine is 2m long between centers and its mass is 250 kg. The mass center is 800 mm from the big end bearing. When suspended as a pendulum from the gudgeon pin axis, it makes 8 complete oscillations in 22 seconds. The crank is 400 mm long and rotates at 200 rpm. When the crank has turned through 40 degree from the top dead center and the piston is moving downwards, find the inertia torque exerted on the crankshaft.

Or

(b) The torque delivered by 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 inner–dead center. The engine speed is 350 rpm. The mass of the flywheel is 450 kg and the radius of gyration 450 mm. Determine, the power developed and the total percentage fluctuation of speed.

12. (a) A shaft carries five masses A, B, C, D and E which revolve at the same radius in planes which are equidistant from one another. The magnitude of the masses in planes A, C and D 50 kg, 40 kg and 80 kg respectively. The angle between A and C is 90° and between C and D is 135°. Determine the magnitude of the masses in planes B and E and their positions to put the shaft in complete rotating balance.

Or

(b) The following data refer to a two–cylinder locomotive with cranks at 90° : Reciprocating mass per cylinder = 300 kg ; crank radius = 0.3 m ; driving wheel diameter = 1.8 m ; distance between cylinder centre lines = 0.65 m ; distance between the driving wheel central planes = 1.55 m.

Determine :

(i) the fraction of the reciprocating masses to be balanced, if the hammer blow is not to exceed 50 KN at 100 km/hr ;

(ii) the variation in tractive effort and

(iii) the maximum swaying couple.

13. (a) A machine of mass 20 kg is mounted on springs of stiffness 100 N/cm and dashpots of damping coefficient 1.5 N–s/cm. If the system is initially at rest and a velocity of 10 cm/s is imparted to the mass, determine

(i) the displacement and velocity of the mass as a function of time and

(ii) the displacement and velocity at t = 1 sec.

Or

(b) The two rotors A and B are attached to the end of shaft 500 mm long. The mass of the rotor A is 300 Kg and its radius of gyration is 300 mm. The corresponding values of the rotor B are 500 kg and 450 mm respectively. The shaft is 70 mm in diameter for the first 250 mm ; 120 mm for the next 70 mm and 100 mm diameter for the remaining length. The modulus of rigidity for the shaft materials is 80 GN/m^2 . Find the location of the node and the natural frequency of torsional vibration.

14. (a) A variable speed motor of mass 600 kg is supported on rubber mountings which have a stiffness of 250 kN/m. The mountings also provide a viscous damping force. The motor produces a sinusoidal force of 1.3 $\omega^2 \sin \omega t$, where ω is the rotational speed of the motor in rad./s. The amplitude of vibration of the system at resonance is observed to be 14 mm.

(i) Estimate the damping ratio of the mountings.

(ii) Calculate the force transmitted to the foundations when the motor speed is 450 rpm.

Or

(b) The springs of an automobile trailer are compressed 10.16 cm under its weight. Find the critical speed when the trailer is travelling over a road with a profile approximately by a sine wave of amplitude 7.62 cm and wavelength of 14.63 m. What will be the amplitude of vibration at 64.4 km/h? (Neglect damping).

15. (a) A porter governor with links 15 cm long has a line of pivot points offset by 3 cm from the vertical axis of the governor. There are two fly masses each equal to 1.75 kg and the central sleeve equal to 25 kg. In the configuration when the angles of inclination of the links to the governor axis are 30°, the governor sleeve starts lifting at 300 rpm. If the friction between the sleeve and the spindle is constant, determine the higher and lower speed of operations of governor in the configuration when the angles made by the links are 45° each.

Or

(b) The turbine rotor of a ship, which rotates, clockwise looking from the aft, has a mass of 5000 kg with radius of gyration of 65 cm. It rotates at 2200 rpm. The ship pitches 5 degrees above the below the horizontal position with simple harmonic motion with a period of oscillation 20 seconds. Determine the maximum reaction gyroscopic couple applied to the ship and its effect when bow is falling.
