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R 3458

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2007.

Fifth Semester

(Regulation 2004)

Mechanical Engineering

ME 1301 — DYNAMICS OF MACHINERY

(Common to B.E. Part-Time – Fourth Semester – Regulation 2005)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define D'Alembert's principle.
2. Define crank effort.
3. What is meant by balancing of rotating masses?
4. Define the term swaying couple.
5. What is meant by degrees of freedom in a vibrating system?
6. Define critical speed.
7. Define Magnification factor.
8. Explain the term 'vibration isolation'.
9. Write a note on 'Hunting of Governors'.
10. Write the expression for Gyroscopic Couple.

PART B — (5 × 16 = 80 marks)

11. (a) In a reciprocating engine mechanism, if the crank and the connecting rod are 300 mm and 1 m long respectively and the crank rotates at a constant speed of 200 r.p.m. Determine analytically,
- (i) The crank angle at which the maximum velocity occurs and (3)
 - (ii) Maximum velocity of the piston. (3)
 - (iii) Derive the relevant equations. (10)

Or

- (b) A vertical double acting steam engine has a cylinder 300 mm diameter and 450 mm stroke and runs at 200 r.p.m. The reciprocating parts has a mass of 225 kg and the piston rod is 50 mm diameter. The connecting rod is 1.2 m long. When the crank has turned through 125° from the top dead centre the steam pressure above the piston is 30 kN/m^2 and below the piston is 1.5 kN/m^2 . Calculate
- (i) Crank-pin effort and (12)
 - (ii) The effective turning moment on the crank shaft. (4)

12. (a) (i) Four masses m_1, m_2, m_3 and m_4 attached to a rotating shaft on the same plane 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 $45^\circ, 75^\circ$ and 135° . Find the position and magnitude of the balance mass required, if its radius of rotation is 0.2 m. (10)
- (ii) Explain with neat sketches, balancing of a single revolving mass, by masses in two different planes in a rotating system. (6)

Or

- (b) A four cylinder vertical engine has cranks 150 mm long. The planes of rotation of the first, second and fourth cranks are 400 mm, 200 mm and 200 mm respectively from the third crank and their reciprocating masses are 50 kg, 60 kg and 50 kg respectively. Find the mass of the reciprocating parts for the third cylinder and the relative angular positions of the cranks in order that the engine may be in complete primary balance. (16)

13. (a) (i) 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. (10)
- (ii) Explain with sketches different cases of damped vibrations. (6)

Or

(b) A steel shaft 1.5 m long is 95 mm in diameter for the first 0.6 m of its length, 60 mm in diameter for the next 0.5 m of the length and 50 mm in diameter for the remaining 0.4 m of its length. The shaft carries two flywheels at two ends, the first having a mass of 900 kg and 0.85 m radius of gyration located at the 95 mm diameter end and the second having mass of 700 kg and 0.55 m radius of gyration located at the order end. Determine the location of the node and the natural frequency of free torsional vibration of the system. The modulus of rigidity of shaft material may be taken as 80 GN/m². (16)

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 $150 \cos 50t$ 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 0.5 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. (6)

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

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

15. (a) A porter governor has equal arms each 250 mm long and pivoted on the axis of rotation. Each ball has a mass of 5 kg and the mass of the central load on the sleeve is 25 kg. The radius of rotation of the ball is 150 mm when the governor begins to lift and 200 mm when the governor is at maximum speed. Find the minimum and maximum speeds and range of speed of the governor. (16)

Or

(b) (i) Explain the effect of Gyroscopic couple on a Naval ship during pitching. (8)

(ii) Explain the effect of Gyroscopic couple on a Aeroplane. (8)