Register Number……

B.E. DEGREE EXAMINATIONS: APRIL / MAY 2010

Fourth Semester

MECHATRONICS ENGINEERING

U07MH402: Dynamics of Machinery

Time: Three Hours **Maximum Marks: 100**

Answer ALL the Questions:-

PART A (10 x 1 = 10 Marks)

1. The rigid body is replaced by two concentrated masses rigidly connected together. The system will be kinetically equivalent of the body if

   A. the mass of two masses is equal to the mass of rigid body

   B. the centre of gravity of two mass system coincides with the centre of gravity of rigid body.

   C. the mass moment of inertia of the two mass system and the rigid body about centre of gravity are equal

   D. all of the above.

2. The principle that reduces the problem of kinetics to equivalent problem on statics is :

   A. Rayleigh principle B. Dunkerley's principle

   C. Newtons law of motion. D. D'Alembert's principle.

3. In order to balance the reciprocating mass of reciprocating engine

   A. Primary forces must balance B. Primary couples must balance

   C. Secondary forces must balance D. All of the above

4. In partial balancing of locomotives, the maximum variation of tractive effort in Newtons

   A. $2/3m\omega^2r$ B. $\sqrt{2}/3\ m\omega^2r$ C. $\sqrt{3}/\sqrt{2}\ m\omega^2r$ D. $1/2\ m\omega^2r$

5. When the frequency of external exciting force is equal to the natural frequency of vibration of the system

   A. the amplitude of vibration is zero.

   B. the amplitude of vibration is insignificantly small.

   C. the amplitude of vibration is very large.

   D. the amplitude of vibration may be large or small depending on the magnitude of frequency.

6. Three rotors connected by shafts when subjected to torsional vibration will have

   A. two nodes B. three nodes C. one node D. no nodes

7. In damped force vibration system

   A. the spring force vector acts in the direction opposite to the displacement.

   B. the damping force vector acts in the direction opposite to the velocity

   C. the inertia force vector acts in the direction opposite to the acceleration.

   D. all of the above statements are true.

8. Rotating shafts tend to vibrate violently in transverse direction at certain speed. This speed is called

A. Critical speed B. Whirling speed C. Whipping speed D. All of the above.

9. Choose the correct statement

A. The Governor reduces the speed fluctuation during a cycle of engine for steady constant output torque.

B. The Governor maintains the speed of the engine within prescribed limits for varying torque output onditions.

C. The Governor does not have any influence on the speed of the engine.

D. The Governor does not have any influence on the varying load of the engine

10. The axis of spin, the axis of precession and axis of applied gyroscopic torque are contained in

A. one plane B. Two planes perpendicular to each other

C. Three planes perpendicular to one other D. none of the above

PART B (10 x 2 = 20 Marks)

11. What is the importance of having a fly wheel in engines?
12. Define the Principle of Superposition in Force Analysis.
13. Differentiate Static and Dynamic Balancing.
14. Mention the types in Balancing linkages.
15. Distinguish Resonance and Damping in Mechanical vibrations.
16. What do you understand by longitudinal , transverse and torsional free vibrations.
17. Define the term "Critical Damping".
18. What is the difference between force transmissibility and amplitude transmissibility?
19. What is hunting of Governors?
20. Define the terms spin, precession and gyroscopic acceleration.

PART C (5 x 14 = 60 Marks)

21. (a) (i) Explain with sketch the Inertia force analysis in a Reciprocating engine considering the mass of connecting rod. (7)

(ii) Connecting rod of a gas engine has mass of 70 kg and has a radius of gyration 36 cm about an axis through the centre of gravity. The length of the rod between centres is 100cm and the centre of gravity is 33cm from the crank pin centre. If the crank length is 22.5 cm and revolves at a uniform speed of 270 rpm, determine the magnitude and the direction of the inertia force on the rod and the corresponding torque on the crankshaft when inclination to IDC is (a)30^0 (b)135^0 (7)

(OR)

(b) The turning moment diagram for a multicylinder engine has been drawn to a scale of 1cm to 5000 N-m torque and 1 cm to 60^0 respectively. The intercepted areas between output torque curve and mean resistance line taken in order from one end are:

- 0.3; + 4.1; - 2.8; +3.2, - 3.3; +2.5: -3.6: +2.8; -2.6 cm^2 when the engine is running at 800 rpm. The engine has a stroke of 30cm and the fluctuation of speed is not to exceed 2% of the mean speed. Determine a suitable diameter and cross-section of the flywheel rim for a limiting value of the shaft centrifugal stress of 280 x 10^5 N/m^2. The material density may be assumed as 7.2 g/cm^3. Assume thickness of the rim to be ¼ of the width.

22. (a) (i) Brief about the balancing of several masses revolving in the same plane. (6)

(ii) The four masses m_1, m_2, m_3, m_4 are respectively 200 kg, 300 kg, 240 kg and 260 kg . The corresponding radii of rotation are 20cm, 15cm, 25cm and 30cm and the angles α,β and γ are 45^0,75^0 and 135^0. Find the position and magnitude of the balance mass required if the radius of rotation is 20cm. (8)

(OR)

(b) (i) Brief the effects of partial balancing in locomotives. (6)

(ii) Prove that the resultant unbalanced force is minimum when half of the reciprocating masses are balanced by rotating masses. (8)

23. (a) (i) Explain the term "critical damping". What is it's influence on the periodicity of natural vibrations. (6)

(ii) A machine of mass 20kg is mounted on springs and dashpots as shown schematically in Fig 1. The total stiffness of the spring is 100 N/cm and the total damping is 1.5 N sec/cm. If the system is initially at rest and a velocity of 10cm/sec is imparted to the mass, determine (a) the displacement and velocity of the mass as a function of time and (b) the displacement and velocity at the time equal to one second. (8)

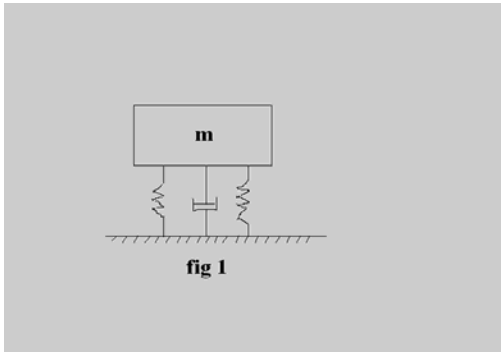

fig 1

(OR)

(b) (i) Derive an expression for natural frequency of free transverse vibration for simply supported beam with more than one concentrated load. (7)

(ii) Determine the natural frequency of transverse vibrations of a 50mm diameter shaft simply supported at the ends 3m apart. Shaft carries 3 point loads of masses 100kg, 150kg and 75 kg at 1m, 2m and 2.5m from the left support. The Young's modulus for the shaft material is 2 x 10^6 bar. Assume the mass of shaft as negligible. (7)

24. (a) (i) Explain with the help of vector diagram the equation of forced damped vibration. (6)

(ii) A vibrating system consists of a mass of 7 kg, a spring of stiffness 50 N/cm and damper of damping co-efficient of 0.36 N/cm sec. Find the damping factor , the logarithmic decrement and the ratio of any two consecutive amplitudes. (8)

(OR)

(b) (i) With neat diagrams explain the torsional vibration of three rotor system. (7)

(ii) A machine part of a mass 2 kg vibrates in a viscous medium. Determine the damping co-efficient when a harmonic exciting force of 25 N results in a reasonable amplitude of 1.25cm with a period of 0.20 second. If the system is excited by a harmonic force of frequency 4 cycles/sec, what will be the percentage of increase in the amplitude of forced vibration when damper is removed. (7)

25. (a) (i) Classify the Governors. (6)

(ii) The arms of a Porter governor are each 25cm long and pivoted on the governor axis.Mass of each ball is 5 kg and the mass of the central sleeve is 30 kg. The radius of rotation of the balls is 15 cm when the sleeve begins to rise and reaches a value of 20cm for maximum speed. Determine speed range of the governor. If the friction of the sleeve is equivalent to 20N of load, determine how the speed range is modified. (8)

(OR)

(b) Derive the expression for gyroscopic torque in terms of angular velocity of spin, angular velocity of precision and polar moment of inertia of a disc.

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