8. Find the frequency of transverse vibrations of a shaft which is simply supported at the ends having 40 mm in diameter and 2·5 m in length. The shaft carries three point loads of masses 30 kg, 70 kg and 45 kg at 0·5 m, 1 m and 1·7 m respectively from left end support. The Young's modulus of the material of the shaft is 200 GN/m^2. Neglect the weight of the shaft. 14

9. *(a)* What do you understand by fluctuation of energy of a reciprocating engine? Define the terms *(i)* coefficient of fluctuation of energy and *(ii)* coefficient of fluctuation of speed.

(b) A vertical steel shaft 15 mm in diameter is held in a long bearing 1 metre apart and carries at its middle a disc weighing 150 newtons. The eccentricity of the CG of the disc from the centre of the rotor is 0·40 mm. The permissible stress of the shaft material is 7 kN/cm^2 and $E = 2 \times 10^7$ N/cm^2. Determine *(i)* the critical speed of the shaft and *(ii)* the range of speed over which it is unsafe to run the shaft. Neglect the weight of the shaft. 7+7=14

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B.Tech. 5th Semester Exam., 2013

DYNAMICS OF MACHINERY

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

(ii) There are ***NINE*** *questions in this paper.*

(iii) Attempt ***FIVE*** *questions in all.*

(iv) Question No. ***1*** *is compulsory.*

(v) Any missing data may be assumed suitably.

1. Choose/Answer any *seven* of the following questions : 2×7=14

(a) When the crank is at the inner dead centre, in a horizontal reciprocating steam engine, then the velocity of the piston will be

(i) zero

(ii) minimum

(iii) maximum

(b) In TMD, the variation of energy above and below the mean resisting torque line is called

(i) fluctuation of energy

(ii) maximum fluctuation of energy

(iii) coefficient of fluctuation of energy

(iv) None of the above

(c) The size of the cam depends upon
  (i) base circle
  (ii) pitch circle
  (iii) prime circle
  (iv) pitch curve

(d) The cam follower generally used in automobile engines is
  (i) knife-edge follower
  (ii) flat-faced follower
  (iii) spherical-faced follower
  (iv) roller follower

(e) Define axis of spin.

(f) The primary unbalanced force is maximum when the angle of inclination of the crank with the line of stroke is
  (i) 0°
  (ii) 90°
  (iii) 180°
  (iv) 360°

(g) The swaying couple is maximum or minimum when the angle of inclination of the crank to the line of stroke is equal to
  (i) 45° and 135°
  (ii) 90° and 135°
  (iii) 135° and 225°
  (iv) 45° and 225°

Determine the gyroscopic couple and its effect on the ship—
  (i) when the ship is steering to the left on a curve of 100 metres radius at a speed of 40 km/hr;
  (ii) when the ship is pitching in an SHM, the bow falling with its maximum velocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 14°.

7+7=14

7. (a) Define the following :
  (i) Variation of tractive force
  (ii) Swaying couple
  (iii) Hammer blow

(b) A four-cylinder vertical engine has cranks 300 mm long. The planes of rotation of the first, third and fourth cranks are 750 mm, 1050 mm and 1650 mm respectively from that of the second crank and their reciprocating masses are 150 kg, 400 kg and 250 kg respectively.
Find the mass of the reciprocating parts for the second cylinder and the relative angular positions of the cranks in order that the engine may be in complete primary balance. 4+10=14

(b) The following particulars relate to a symmetrical tangent cam, operating a roller follower :

Least radius = 30 mm
Nose radius = 24 mm
Roller radius = 18 mm
Distance between camshaft and nose center = 24 mm
Angle of action of cam = 150°
Camshaft speed = 600 r.p.m.

Assuming that there is no dwell between ascent and descent, determine the lift of the valve, and acceleration of the follower at a point, where straight flank merges into the circular nose. 7+7=14

6. (a) Explain the meaning of the term 'gyroscopic torque'. Deduce the expression for the gyroscopic torque in terms of the moment of inertia of the spinning body, the angular velocity of spin and the angular velocity of precession.

(b) The turbine rotor of a ship has a mass of 4500 kg. It has a radius of gyration of 0·55 m and a speed of 4000 r.p.m. clockwise when looking from the stern.

(h) When there is a reduction in amplitude over every cycle of vibration, then the body is said to have
(i) free vibration
(ii) forced vibration
(iii) damped vibration

(i) When a body is subjected to transverse vibrations, the stress induced in a body will be
(i) shear stress
(ii) tensile stress
(iii) compressive stress

(j) At a nodal point in a shaft, the amplitude of torsional vibration is
(i) zero
(ii) minimum
(iii) maximum

2. (a) What is dynamically equivalent system? State the necessary conditions. Derive the expression, $k^2 = L_1 L_2$, where k = radius of gyration about its centre of gravity G of a body of mass m, L_1 = distance of mass m_1 from G, L_2 = distance of mass m_2 from G.

(b) A small connecting rod 220 mm long between centres, has a mass of 3 kg and moment of inertia of 2×10^4 kg mm^2

Code : 021513

B.Tech 5th Semester Examination, 2016

Dynamics of Machinery

Time : 3 hours *Full Marks : 70*

Instructions :

(i) The marks are indicated in the right-hand margin.

(ii) There are Nine questions in this paper.

(iii) Attempt five questions in all.

*(iii) **Question No. 1 is Compulsory.***

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1. Choose the correct answer of the following (any seven): 2×7=14

(a) The cam follower used in air-craft engine is a ..... follower:

(i) Roller

(ii) flat-faced

(iii) spherical faced

(iv) knife-edge

(b) The size of the cam depends on:

(i) Pitch circle

(ii) prime circle

(iii) base circle

(iv) pitch curve

(c) The maximum fluctuation of energy in a flywheel is equal to :

(i) $I\omega(\omega 1 - \omega 2)$

(ii) $I\omega^2 K$

(iii) $2KE$

(iv) All

(d) For complete dynamic balance, at least..... mass/masses are necessary:

(i) One

(ii) Two

(iii) Three

(iv) Four

(e) The Primary unbalanced force is maximum, when the angle of crank with the line of stroke is:

(i) 45°

(ii) 90°

(iii) 135°

(iv) 180°

(f) The gyroscopic acceleration is give by:

(i) $\delta\omega/\delta t$

(ii) $\omega \cdot \delta\theta/\delta t$

(iii) $r \cdot \delta\theta/\delta t$

(iv) $r \cdot \delta\omega/\delta t$

(g) In free vibration, the acceleration vector leads the displacement vector by:

(i) π

(ii) $\pi/2$

(iii) $\pi/3$

(iv) $2\pi/3$

(h) The frequency of damped vibration is always..... the natural frequency.

(i) equal to

(ii) more than

(iii) less than

(iv) double

(i) A torsional vibratory system having two rotors connected by a shaft has:

(i) One node

(ii) Two node

(iii) Three node

(iv) No node

(j) The axis of spin, the axis of precession and the axis of gyroscopic torque are in:

(i) Two parallel planes

(ii) Two perpendicular planes

(iii) Three perpendicular planes

(iv) Three parallel Planes

2 Draw the profile of a cam operating a roller reciprocating follower and with the following data: Minimum radius of cam = 25 mm. Lift = 30 mm. Roller diameter = 15 mm. The cam lifts the follower for 120° with SHM followed by a dwell period of 30°. Then the follower lowers down during 150° of the cam rotation with uniform acceleration and deceleration followed by a dwell period. If the cam rotates at a uniform velocity of 150 rpm, calculate the maximum velocity and acceleration of the follower during the descent period. 14

3. Derive the expression for maximum and minimum accelerations for a tangent cam with roller follower, assuming roller follower is in direct contact with the circular flank. 14

4. (a) Find a relation for the coefficient of fluctuation of speed in terms of maximum fluctuation of energy and the kinetic energy of the flywheel at mean speed.

(b) The turning moment diagram for a spark ignition engine is drawn to a vertical scale of 1 mm = 500 N.m and a horizontal scale of 1 mm = 3°. The turning moment diagram repeats itself every half revolution of the crankshaft.

The areas above and below the mean torque line are 260, –580, 80, –380, 870, and –250 mm². The rotating parts have a mass of 55 kg and radius of gyration of 2.1 m. If the engine speed is 1600 rpm, determine the coefficient of fluctuation of speed. 10

5. Explain the gyroscopic effect on four-wheeled vehicles. What is the effect of gyroscopic couple on the stability of a four wheeler while negotiating a curve? 14

6. In a vertical double-acting steam engine, the connecting rod is 4.5 times the crank. The weights of the reciprocating part are 120 kg and the stroke of the piston is 440 mm. The engine runs at 250 rpm. If the net load on the piston due to steam pressure is 25 kN when the crank has turned through an angle of 120° from the top dead centre, determine the following:
   (a) Thrust in the connecting rod.
   (b) Pressure on the slide bars.
   (c) Tangential force on the crank pin.
   (d) Thrust on the bearings.
   (e) Turning moment on the crankshaft. 14

7. A rotor is completely balanced when masses of 2 kg are added temporarily in planes A and D each at 200 mm radius as shown in figure (a). The balanced mass in

the plane A is along the X-axis whereas in the plane D, it is at 120° counter-clockwise. It is desired that the actual balancing is to be done by adding permanent masses in plane B and C, each at 120 mm radius. Determine the magnitude and directions of the masses B and C. 14

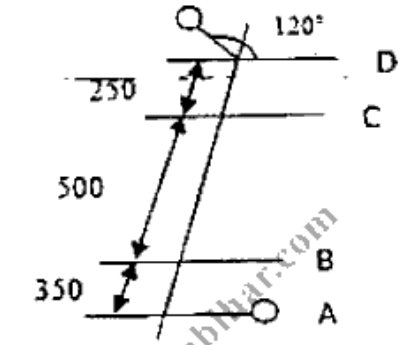

Figure (a)

8. Derive from the first principles, a relation for displacement of mass from equilibrium position of a damped vibrating system with harmonic forcing. Also find graphically the amplitude for the given system. 14

9. The following data relate to a shaft held in long bearings: Length of shaft =1.2 m, Diameter of shaft = 14 mm, Mass of a rotor at midpoint=16 kg, Eccentricity of mass = 0.4 mm, Modulus of elasticity of shaft material=200 GN/m², Permissible stress in shaft material=70 MN/m².

Determine the critical speed of the shaft and the range of speed over which it is unsafe to run shaft. Assume the shaft to be massless. 14

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