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# SIXTH SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION, MARCH 2013

## ME 04 606—DYNAMICS OF MACHINERY

(2004 Scheme)

Time : Three Hours Maximum : 100 Marks

*Answer* **all** *questions.*
*Missing data, if any may be suitably assumed.*
*Clearly mention the assumptions made. Draw neat sketches.*
*Drawing conventions are to be strictly followed.*

1. (a) Name and explain the two different types of steering mechanism. What are their merits and demerits ?

   (b) Explain the principle of virtual work.

   (c) Explain clearly how the functions of flywheel and governor differ from each other in a steam engine.

   (d) A number of masses are attached to a shaft which is rotating at an angular speed of $\omega$ rad/s. If all the masses are in different planes, then describe the analytical method and graphical method of balancing these masses.

   (e) Prove that the natural frequency of free longitudinal vibrations, is given by $f_n = 0.4985/\sqrt{\delta}$ Hz, where $\delta$ = static deflection in meter.

   (f) Describe in details the method of finding the frequency of torsional vibration of a two rotor system.

   (g) A uniform bar of length $l$ and mass $m$ carries at its right end an additional mass, also $m$. It is mounted on two equal spring $k$ at the extremities. Find the two natural frequencies and the corresponding shapes of vibration.

   (h) A system consists of a solid cylinder of radius R and weight W, which rolls without slipping on a horizontal track. To its center is pivoted a uniform bar of total length 3R and weight W, equal to that of the cylinder. Set up the equations of the system, and find the natural frequencies of small oscillations.

   ($8 \times 5 = 40$ marks)

2. (a) The following data are relate to the connecting rod of a reciprocating engine : mass is 50 kg. distance between bearing centres is 900 mm., diameter of big end bearing is 100 mm., diameter of small end bearing is 80 mm. time of oscillation when the connecting rod is suspended from big end for 1.7s and from small end for 1.85 s. Determine : (i) the radius of gyration $k$ of the rod about an axis through centre of mass perpendicular to the plane of oscillation ; (ii) the moment of inertia of the rod about the same axis ; and (iii) the dynamically equivalent system of the connecting rod comprising two masses, one at the small end bearing centre.

*Or*

**Turn over**

(b) The dimensions of a four link mechanism are AB = 500 mm. BC = 600 mm., CD = 560 mm. and AD = 1000 mm. The link AB has an angular velocity of 10.5 rad/s counter clockwise and an angular retardation of 26 rad/s.$^2$ at the instant when it makes a angle of 60° with AD, the fixed link. The mass of the links BC and CD is 4.2 kg/m. length. The link AB has a mass of 3.54 kg. the centre of which lies at 200 mm. from A a moment of inertia of 88500 kg.mm.$^2$ neglecting gravity and friction effects, determine the instantaneous value of the drive torque required to be applied on AB to overcome the inertia forces.

(15 marks)

3. (a) A shaft is rotating at a uniform angular speed. Four masses $m_1$, $m_2$, $m_3$ and $m_4$ of magnitude 300 kg., 450 kg., 360 kg. and 390 kg. respectively are attached rigidly to the shaft. The masses are rotating in the same plane. The corresponding radii of rotation are 200 mm., 150 mm., 250 mm. and 300 mm. respectively. The angles made by these masses with horizontal are 0°, 45°, 120° and 255° respectively. Find (i) the magnitude of the balancing mass and (ii) the position of the balancing mass if its radius of rotation is 200 mm,

*Or*

(b) A 90° V engine has two cylinder which are placed symmetrically. The two connecting rods operate a common crank. The lengths of connecting rods are 320 mm. each and crank radius is 80 mm. The reciprocating mass per cylinder is 12 kg. If the engine speed is 600 r.p.m. then find the resultant primary and secondary forces. Also find the maximum resultant secondary force.

(15 marks)

4. (a) A harmonic exciting force of 25 N is acting on a machine part, which is having a mass of 2 kg. and is vibrating in a viscous medium. The exciting force causes resonant amplitude of 12.5 mm. with a period of 0.20 seconds. Determine the damping coefficient. If the system is excited by a harmonic force of frequency 4 Hz, find the increase in amplitude of forced vibration when damper is removed.

*Or*

(b) The moment of inertia of three rotors A, B and C are respectively 400 kg.-m.$^2$ 160 kg.m$^2$ and 10 kg.m.$^2$ The distance between rotor A and B is 2 m. and they are connected by a shaft of diameter 50 mm. The distance between rotor B and C is also 2 m. and they are connected by a shaft of diameter 25 mm. Determine (i) Natural frequencies of torsional vibrations and (ii) Position of nodes. Take modulus of rigidity as 80 kN/mm.$^2$ and neglect the inertia of the shaft.

(15 marks)

5. (a) An automobile has main springs which are compressed 4 in under the weight of the body. Assume the tires to be infinitely stiff. The car runs over a road surface consisting of sine waves of 1 in amplitude (i.e., having 2 in. height difference between crests and valleys) and with distance of 4.2 ft. between consecutive crests. There are no shock absorbers. (i) find the critical speed of the car ; (ii) find the amplitude of vertical vibration of the chassis at a forward speed of 40 m.p.h.

*Or*

(b) In a turned dynamic vibration absorber which is connected to a SDOF system having a mass of 90 kg., the mass of the absorber is 4.5 kg. and amplitude of disturbing force is 300 N. If the main mass is at rest when the forcing frequency is 100 Hz. Find the amplitude of vibration of the absorber mass and stiffness of the absorber. Also find the stiffness of the SDOF system.

(15 marks)

[4 × 15 = 60 marks]