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Question Paper Code: 41751

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2016

Fifth Semester

Mechanical Engineering

14UME501 - DYNAMICS OF MACHINERY

(Regulation 2014)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. A rigid body, under the action of external forces, can be replaced by two masses placed at a fixed distance apart. The two masses form an equivalent dynamical system, if

   (a) the sum of two masses is equal to the total mass of the body
   (b) the centre of gravity of the two masses coincides with that of the body
   (c) the sum of mass moment of inertia of the masses about their centre of gravity is equal to the mass moment of inertia of the body
   (d) all of the above

2. In a turning moment diagram, the variations of energy above and below the mean resisting torque line is called

   (a) fluctuation of energy (b) maximum fluctuation of energy
   (c) coefficient of fluctuation of energy (d) none of the these

3. In order to have a complete balance of the several revolving masses in different planes

   (a) the resultant force must be zero
   (b) the resultant couple must be zero
   (c) both the resultant force and couple must be zero
   (d) none of the these

4. In a locomotive, the ratio of the connecting rod length to the crank radius is kept very large in order to

   (a) minimize the effect of primary forces
   (b) minimize the effect of secondary forces
   (c) have perfect balancing
   (d) start the locomotive quickly

5. The factor which affects the critical speed of a shaft is

   (a) diameter of the disc (b) span of the shaft
   (c) eccentricity (d) all the above

6. At a nodal point in a shaft, the amplitude of torsional vibration is

   (a) zero (b) minimum
   (c) maximum (d) none of these

7. When a body is subjected to transverse vibrations, the stress induced in a body will be

   (a) shear stress (b) tensile stress
   (c) compressive stress (d) none of these

8. The ratio of the maximum displacement of the forced vibration to the deflection due to the static force, is known as

   (a) damping factor (b) damping coefficient
   (c) logarithmic decrement (d) magnification factor

9. Which of the following governor is used to drive a gramophone

   (a) Watt governor (b) Porter governor
   (c) Pickering governor (d) Hartnell governor

10. The rotor of a ship rotates in clockwise direction when viewed from the stern and the ship takes a left turn. The effect of the gyroscopic couple acting on it will be

    (a) to raise the bow and stern
    (b) to lower the bow and stern
    (c) to raise the bow and lower the stern
    (d) to lower the bow and raise the stern

PART - B (5 x 2 = 10 Marks)

11. Differentiate between static force analysis and dynamic force analysis.

12. Write the equation for balancing a single rotating mass by a single mass.

13. Mention the various methods of finding the natural frequency of free longitudinal vibrations.

14. Specify the importance of vibration isolation.

15. Define the term stability of the governor.

PART - C (5 x 16 = 80 Marks)

16. (a) The crank and connecting rod lengths of an engine are 125 *mm* and 500 *mm* respectively. The mass of the connecting rod is 60 *kg* and its centre of gravity is 275 *mm* from the crosshead pin centre, the radius of gyration about centre of gravity being 150 *mm*. If the engine speed is 600 *r.p.m*. for a crank position of 45° from the inner dead centre, determine, using Klien's or any other construction (i) The acceleration of the piston; (ii) The magnitude, position and direction of inertia force due to the mass of the connecting rod. (16)

Or

(b) The turning moment diagram for a multi-cylinder engine has been drawn to a scale of 1 *mm* to 500 *N-m* torque and 1 *mm* to 6° of crank displacement. The intercepted areas between output torque curve and mean resistance line taken in order from one end, in *sq. mm* are – 30, + 410, – 280, + 320, – 330, + 250, – 360, + 280, – 260 *sq.mm*, when the engine is running at 800 *r.p.m*. The engine has a stroke of 300 *mm* 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 safe centrifugal stress of 7 *MPa*. The material density may be assumed as 7200 kg/m^3.The width of the rim is to be 5 times the thickness. (16)

17. (a) A shaft carries four masses *A, B, C* and *D* of magnitude 200 *kg*, 300 *kg*, 400 *kg* and 200 *kg* respectively and revolving at radii 80 *mm*, 70 *mm*, 60 *mm* and 80 *mm* in planes measured from *A* at 300 *mm*, 400 *mm* and 700 *mm*. The angles between the cranks measured anticlockwise are *A* to *B* 45°, *B* to *C* 70° and *C* to *D* 120°. The balancing masses are to be placed in planes *X* and *Y*. The distance between the planes *A* and *X* is 100 *mm*, between *X* and *Y* is 400 *mm* and between *Y* and *D* is 200 *mm*. If the balancing masses revolve at a radius of 100 *mm*, find their magnitudes and angular positions. (16)

Or

(b) A five cylinder in-line engine running at 750 *r.p.m*. has successive cranks 144° apart, the distance between the cylinder centre lines being 375 *mm*. The piston stroke is 225 *mm* and the ratio of the connecting rod to the crank is 4. Examine the engine for balance of primary and secondary forces and couples. Find the maximum values

of these and the position of the central crank at which these maximum values occur. The reciprocating mass for each cylinder is 15 *kg*. (16)

18. (a) A machine of mass 75 *kg* is mounted on springs and is fitted with a dashpot to damp out vibrations. There are three springs each of stiffness 10 *N/mm* and it is found that the amplitude of vibration diminishes from 38.4 *mm* to 6.4 *mm* in two complete oscillations. Assuming that the damping force varies as the velocity, determine: (i) The resistance of the dashpot at unit velocity; (ii) The ratio of the frequency of the damped vibration to the frequency of the undamped vibration; and (iii) The periodic time of the damped vibration. (16)

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 a mass of 700 *kg* and 0.55 *m* radius of gyration located at the other 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/m^2. (16)

19. (a) A machine part of mass 2 *kg* vibrates in a viscous medium. Determine the damping coefficient when a harmonic exciting force of 25 *N* results in resonant amplitude of 12.5 *mm* with a period of 0.2 second. If the system is excited by a harmonic force of frequency 4 *Hz* what will be the percentage increase in the amplitude of vibration when damper is removed as compared with that with damping. (16)

Or

(b) A single-cylinder engine of total mass 200 *kg* is to be mounted on an elastic support which permits vibratory movement in vertical direction only. The mass of the piston is 3.5 *kg* and has a vertical reciprocating motion which may be assumed simple harmonic with a stroke of 150 *mm*. It is desired that the maximum vibratory force transmitted through the elastic support to the foundation shall be 600 *N* when the engine speed is 800 *r.p.m*. and less than this at all higher speeds. (i) Find the necessary stiffness of the elastic support, and the amplitude of vibration at 800 *r.p.m*., and (ii) If the engine speed is reduced below 800 *r.p.m*. at what speed will the transmitted force again becomes 600 N? (16)

20. (a) The arms of a Porter governor are 300 *mm* long. The upper arms are pivoted on the axis of rotation. The lower arms are attached to a sleeve at a distance of 40 *mm* from the axis of rotation. The mass of the load on the sleeve is 70 *kg* and the mass of each ball is 10 *kg*. Determine the equilibrium speed when the radius of rotation of the balls is 200 *mm*. If the friction is equivalent to a load of 20 *N* at the sleeve, what will be the range of speed for this position? (16)

Or

(b) A ship propelled by a turbine rotor which has a mass of 5 *tonnes* and a speed of 2100 *r.p.m*. The rotor has a radius of gyration of 0.5 *m* and rotates in a clockwise direction when viewed from the stern. Find the gyroscopic effects in the following conditions: (i) The ship sails at a speed of 30 *km/h* and steers to the left in a curve having 60 *m* radius. (ii) The ship pitches 6 degree above and 6 degree below the horizontal position. The bow is descending with its maximum velocity. The motion due to pitching is simple harmonic and the periodic time is 20 seconds. (iii) The ship rolls and at a certain instant it has an angular velocity of 0.03 *rad/s* clockwise when viewed from stern. Determine also the maximum angular acceleration during pitching. Explain how the direction of motion due to gyroscopic effect is determined in each case. (16)