Reg. No. : | | | | | | | | | | |

Question Paper Code: 45701

B.E. / B.Tech. DEGREE EXAMINATION, DEC 2021

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. In Reciprocating engine primary forces

   (a) are completely balanced (b) are partially balanced
   (c) are balanced by secondary force (d) cannot be balanced

2. A System of masses rotating in different parallel planes is in dynamic balance if the resultant

   (a) Force is equal to zero
   (b) Couple is equal to zero
   (c) Force and the resultant couple are both equal to zero
   (d) Force is numerically equal to the resultant couple but neither of then need necessarily be zero

3. Balancing of a rigid rotor can be achieved by appropriately placing balancing weights in

   (a) Single plane (b) Two plane (c) Three plane (d) Four plane

4. For balancing a single disturbing mass, the minimum number of balance mass required to be introduced in a plane parallel to the plane of rotation of the disturbing mass will be

   (a) Single plane (b) Two plane (c) Three plane (d) Four plane

5. The rotating shafts tend to vibrate violently at whirling speeds because

   (a) The system is unbalanced
   (b) Bearing centre line coincides with the axis
   (c) The shafts are rotating at very high speeds
   (d) Resonance is caused due to the heavy mass of the rotor

6. During transverse vibrations, shaft is subjected to which type of stresses?

   (a) Tensile stresses (b) Torsional shear stress
   (c) Bending stresses (d) none of these

7. Magnification factor is the ratio of

   (a) zero frequency deflection and amplitude of steady state vibrations
   (b) amplitude of steady state vibrations and zero frequency deflection
   (c) amplitude of unsteady state vibrations and zero frequency distribution
   (d) none of these

8. Rotating shafts tend to of vibrate violently at whirling speeds because

   (a) the shaft are rotating at vary speeds
   (b) Bearing centerline coincide with the shaft axis
   (c) the system is un balanced
   (d) Resonance is caused due to the heavy weight of the rotor

9. A Porter governor has a maximum and minimum equilibrium speeds of 200 rpm and 150 rpm respectively. If the effective load on the sleeve is 30 kgf, the governor effort would be

   (a) 1.67 kgf (b) 5.83 kgf (c) 7.5 kgf (d) 10.0 kgf

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. Difference between harmonic forcing and periodic forcing.

15. State the function of governor. Can fly wheel also carry out the function of governor?

PART - C (5 x 16 = 80 Marks)

16. (a) The obliquity ratio of a vertical reciprocating engine is 4. The engine bore and the crank radius are 60 mm and 40 m respectively. The mass of the reciprocating parts is 1 kg. The difference in the gas pressure acting on the two sides of the piston is 5 bar, and the effective gas pressure acts downwards, towards the crank shaft, when the crank has moved 50^0 from the top dead centre position. Determine when crank speed=2000 rpm.

    (i) The piston effort

    (ii) The loads on gudgeon pin and the crank pin

    (iii) The cylinder wall thrust and the thrust on the crank bearing. Neglect the inertia 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) Four masses A,B,C and D are completely balanced. Masses C and D make angle of 90° and 195° respectively with that of mass B in the counter- clockwise direction. The rotating masses have following properties: m_b = 25 kg, m_c = 40 kg, m_d = 35 kg, r_a =150 mm, r_b = 200 mm, r_c = 100 mm, r_d = 180mm. Planes B and C are 250 mm apart. Determine (i) the mass A and its angular position with that of mass B (ii) the position of all the planes relative to plane of mass A. (16)

Or

(b) A four cylinder oil engine is in complete primary balance. The arrangement of the reciprocating masses in different planes is as shown in Fig. The stroke of each piston is 2r mm. Determine the reciprocating mass of the cylinder 2 and the relative crank position. (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 of mass 75 kg is mounted on springs of stiffness 12×10^5N/m and with an assumed damping factor of 0.2. A piston within the machine of mass 2 kg has a reciprocating motion with a stroke of 80 mm and a speed of 3000 cycles/min. Assuming the motion to be simple harmonic, find (i) the amplitude of motion of the machine, (ii) its phase angle with respect to existing force, (iii) the force transmitted to the foundation, and (iv) the phase angle of transmitted force with respect to the existing force, and (v) the phase lag of transmitted force with respect to the applied force. (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) Each arm of a Porter governor is 250 mm long. The upper and lower arms are pivoted to links of 40 mm and 50 mm respectively from the axis of rotation. Each ball has a mass of 5 kg and the sleeve mass is 50 kg. The force of friction on the sleeve of the mechanism is 40 N. Determine the range of speed of the governor for extreme radii of rotation of 125 mm and 150 mm. (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)

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