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Question Paper Code: 45701

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2018

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. 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. 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

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 ratio of actual damping co-efficient to the critical damping co-efficient is known as

(a) Critical damping (b) Damping factor
(c) Magnification factor (d) Logarithmic decrement

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. For a vibrating body under steady state forced vibration, if ratio $\omega/\omega n$ is very low, the phase angle would tend to approach

(a) 0° (b) 90° (c) 180° (d) 270°

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

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

PART - B (5 x 2 = 10 Marks)

11. Define Coefficient of fluctuation of speed and energy of a flywheel.

12. Why rotating masses are to be dynamically balanced?

13. Define Degree of freedom.

14. Specify the importance of vibration isolation.

15. What is the governor and their types.

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) 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 four cylinder in-line engine running at 2000 r.p.m is having crank and connecting rod lengths of 60 mm and 240 mm respectively. The mass of reciprocating parts of each cylinder is 2 kg. The cylinders are spaced 160 mm apart and the cranks appear at 90^0 intervals in an end view. If the firing order of the engine is 1-4-2-3, Determine:

(i) The unbalanced primary and secondary forces; and

(ii) The unbalanced primary and secondary couples (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 supported symmetrically on four spring has a mass of 80 kg. The mass of the reciprocating parts is 2.2 kg which move through a vertical stroke of 100 mm with simple harmonic motion. Neglecting damping, determine the $1/20^{th}$ of the impressed force. The machine crankshaft rotates at 800 rpm. If under actual working conditions, the damping reduces the amplitudes of successive vibration by 30/-, find (i) The force transmitted to the foundation at 800 rpm (ii) The force transmitted to the foundation at resonance, and The amplitude of the vibration at resonance. (16)

Or

(b) 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)

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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