

**DYNAMICS OF MACHINES
(MECH 3101)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

Candidates are required to give answer in their own words as far as practicable.

**Group – A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Gyroscopic effect is not observed in which of the following actions performed by the ships?
(a) Rolling (b) Pitching
(c) Steering (d) All of the above.
- (ii) Which of the following governor is spring loaded?
(a) Watt governor (b) Porter governor
(c) Proell governor (d) Hartnell governor.
- (iii) The ratio of maximum fluctuation of speed to mean speed is called
(a) coefficient of fluctuation of energy
(b) fluctuation of energy
(c) coefficient of fluctuation of speed
(d) Fluctuation of speed.
- (iv) The pitching of a ship produces force on the bearings which act_____ to the direction of motion of the ship.
(a) Vertically and perpendicular (b) Vertically and parallel
(c) Horizontally and perpendicular (d) Horizontal and parallel
- (v) The maximum magnitude of the unbalanced force in a line perpendicular to the line of stroke is known as
(a) Swaying couple (b) Hammer Blow
(c) Variation in tractive effort (d) Unbalanced Force.
- (vi) The primary unbalanced force is maximum when the angle of inclination of the crank with the line of stroke is
(a) 0° and 90° (b) 180° and 360°
(c) 90° and 180° (d) 0° and 180°.

- (vii) For isochronous spring controlled governor, the controlling force with increase in radius of rotation
(a) increases
(b) decreases
(c) remains constant
(d) may increase or decrease depending on size.
- (viii) In vibration isolation system, if $\omega/\omega_n > 1$, then the phase difference between the transmitted force and the disturbing force is
(a) 0° (b) 90° (c) 180° (d) 270° .
- (ix) A body of mass m and radius of gyration ' K ' is to be replaced by two masses m_1 and m_2 located at distances h_1 and h_2 respectively from the centre of mass of the original body. These will be kinetically equivalent to original body if
(a) $h_1 + h_2 = k$ (b) $h_1^2 + h_2^2 = k^2$
(c) $h_1 h_2 = k^2$ (d) $h_1 h_2 = k$.
- (x) For a critically damping system, the motion will be
(a) periodic (b) aperiodic (c) harmonic (d) random.

Group - B

2. (a) Discuss D' Alembert principle.
- (b) A small connecting rod 200 mm long between centres has a mass of 2.5 kg and moment of inertia of 2.5×10^4 kg-mm² about its centre of gravity. Centre of gravity is located at a distance of 150 mm from the small end centre. Determine a dynamically equivalent two mass system, when one mass is located at the small end centre.
If the connecting rod is replaced by two masses located at the two centres, find the correction couple that must be applied for complete dynamically equivalent two mass systems when the angular acceleration of the connecting rod is 17000 rad/s² clockwise.

3 + (6 + 3) = 12

3. (a) Find the natural frequency of the system as shown in figure 1:

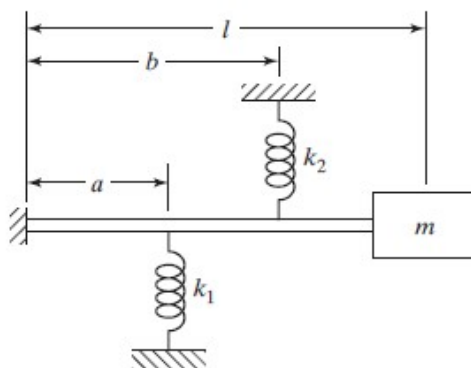


Figure 1

- (b) Find the natural frequency of the system as shown in figure 2.

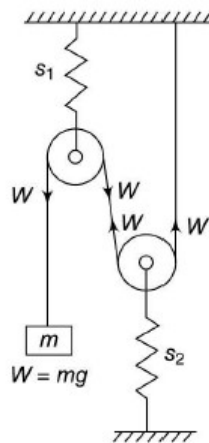


Figure 2

6 + 6 = 12

Group – C

4. (a) A machine weighs 20 kg and is supported on springs and dashpots. The total stiffness of the springs is 15 N/mm and the damping is 0.3 N/(mm/s). is initially at rest and a velocity of 100 mm/s is imparted to the mass.
Determine:
 - I. Displacement and velocity of the mass as a function of time.
 - II. Displacement and velocity after 0.5 second.
 - (b) What do you understand by over-damping and critical-damping?
5. (a) What do you understand by 'Whirling of Shaft'? Explain in detail.
 - (b) A shaft 30 mm diameter and 2 m long has a mass of 10 kg per metre. It is simply supported at the ends and carries three masses 60 kg, 70 kg and 80 kg at 0.7 m, 1 m and 1.5 m respectively from the left support. Taking $E = 207 \text{ GPa}$, find the frequency of the transverse vibrations.

8 + 4 = 12

5 + 7 = 12

Group – D

6. (a) Four masses A, B, C and D are rigidly attached to a shaft. The radii of rotation are 55 mm, 75 mm, 80 mm and 60 mm from the axis of rotation. The magnitude of masses A, C and D are 10 kg, 12 kg and 10 kg respectively. Axial distance between the planes of rotation A and B are 300 mm whereas between B and C is 400mm. The masses A and C are at right angled to each other. If the masses are in complete balance, then find
 - i. the angle of masses B and D from mass A
 - ii. the axial distance between the planes of rotation of C and D
 - iii. the magnitude of mass B.
- (b) Find the magnitude of maximum unbalanced primary couple and secondary couple for a two cylinder in-line engine assuming the crank position to be placed 180° apart and having equal reciprocating mass.

(5 + 2 + 1) + 4 = 12

7. (a) Deduce the expression for maximum variation of tractive force and swaying couple for an uncoupled two cylinder locomotive engine.
- (b) The following data refers to two-cylinder locomotive with cranks at 90° . Reciprocating mass per cylinder = 210 kg, Crank radius = 0.2 m, Driving wheel diameter = 1.8 m, Distance between cylinder centre lines = 0.8 m, Distance between the driving wheel central planes = 1.6 m. Determine
- The fraction of reciprocating masses to be balanced, if the hammer blow is not to exceed 40 kN at 100 km/h.
 - The variation of tractive force
 - The maximum swaying couple.

4 + 8 = 12**Group – E**

8. (a) Write short note: Isochronism, Sensitiveness and Hunting.
- (b) Each arm of a porter governor is 200 mm long and is pivoted on the axis of rotation. Each ball has a mass of 6 kg and the sleeve weight is 18 kg. The radius of rotation of the ball is 50 mm when the governor begins to lift and 150 mm when the speed is maximum. Determine the maximum and minimum speeds and the range of speed of the governor.
9. (a) The turbine rotor of a ship of mass 5000 kg has a radius of gyration 60 cm. It rotates at 1800 rpm clockwise when looking from stern. Determine the gyroscopic couple and its effect when
- The ship is travelling at 50 km/hr, steers to the left in a curve of 75 metre radius.
 - The ship is pitching and the bow is descending with the maximum velocity. The pitching is simple harmonic, periodic time being 25 seconds, and the total angular movement between the extreme positions is 15° . In each explain clearly the direction in which the ship tends to move as a result of gyroscopic action.
- (b) Explain in what way the gyroscopic couple affects the motion of an aircraft while taking a turn.

(2 × 3) + 6 = 12**7 + 5 = 12**

Department & Section	Submission link:
ME	https://classroom.google.com/c/Mjc0NzM2NjQ3NjQz/a/Mjc1NTk4MzkwODY1/details