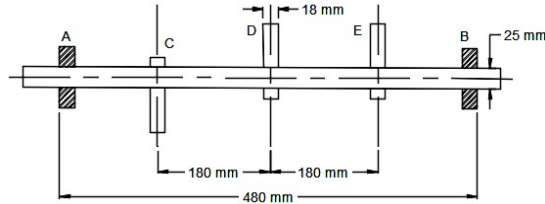


7. (a) The cam shaft of high speed pump consists of a parallel shaft 25 mm diameter and 600 mm long. It carries three eccentrics, each of diameter 60 mm and a uniform thickness of 18 mm. the assembly is symmetrical as shown in figure below and the bearings are at A and B. The angle between the eccentrics is 120° and the eccentricity of each is 15 mm. The material density is 7000 kg/m³, and the speed of rotation of 1450 r.p.m.



- Find :
- Dynamic load on each bearing due to the out of balance couple,
 - Direction of dynamic force at bearing A and B, and
 - Kinetic energy of the complete assembly.

- (b) Why complete balancing of reciprocating mass is not possible?

9 + 3 = 12

Group - E

8. (a) What is the function of a governor?
 (b) The arms of a Proell governor are 25 cm long. The upper arms are pivoted on the axis of rotation, while the lower arms are pivoted at a radius of 3 cm. Each ball weighs 6 kgf and is attached to an extension 80 mm long of the lower arm; the central weight is 50 kgf. At the minimum radius of 15 cm the extension to which balls are attached are parallel to the governor axis.
 Ignoring the friction between spindle and sleeve find:
 i. The equilibrium speed corresponding to a radius of 15 cm.
 ii. The speed at which radius is 18 cm.

2 + 10 = 12

9. A four wheeled motor car of mass 2500 kg has a wheel base 3 m, track width 2 m and height of center of gravity 300 mm above the ground level and lies at 1.3 m from the front axle. Each wheel has an effective diameter of 0.6 m and a moment of inertia of 0.7 kg-m². The drive shaft, engine flywheel and transmission are rotating at 2 times the speed of road wheel, in a clockwise direction when viewed from the front, and is equivalent to a mass of 60 kg having a radius of gyration of 90 mm. If the car is taking a right turn of 60 m radius at 50 km/h, find the load on each wheel.

12

**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**
- 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.
 - The equivalent spring constant of two springs in series with stiffness k_1 and k_2 is
 (a) $k_1 + k_2$ (b) $\frac{k_1+k_2}{k_1k_2}$ (c) $\frac{k_1k_2}{k_1+k_2}$ (d) $k_1 - k_2$.
 - 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°.
 - 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°.
 - The amplitude of an undamped system subject to an initial displacement 0 and initial velocity
 (a) \dot{x}_0 (b) $\dot{x}_0\omega_n$ (c) $\frac{\dot{x}_0}{\omega_n}$ (d) ω_n .
 Here every notation and symbol carry their usual meaning.
 - 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.

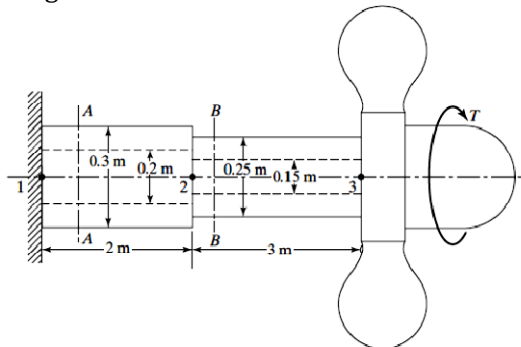
- (vii) For a viscous damper with damping constant c , the damping force is:
 - (a) c
 - (b) $c\dot{x}$
 - (c) $c\ddot{x}$
 - (d) $c\dot{x}$
- (viii) In order to facilitate starting of locomotive in any position, the cranks of a locomotive with two cylinders, are placed at
 - (a) 45° to each other
 - (b) 90° to each other
 - (c) 120° to each other
 - (d) 180° to each other.
- (ix) If the ratio of length of connecting rod to crank radius increases then
 - (a) The primary force increases
 - (b) the primary force decreases.
 - (c) The secondary force increases
 - (d) the secondary force decreases.
- (x) Which of the following governor is spring loaded?
 - (a) Watt governor
 - (b) Porter governor
 - (c) Proell governor
 - (d) Hartnell governor.

Group - B

- 2. (a) The connecting rod of an IC engine is 500 mm long and has a mass of 3 kg. The centre of mass of the rod is 275 mm from the small end and its radius of gyration about an axis through this centre is 175 mm. The mass of the piston and the gudgeon pin is 3 kg and the stroke is 200 mm. The cylinder diameter is 95 mm. The engine speed is 1500 RPM. When the crank is 60° and the piston is moving away from the inner dead centre under an effective gas pressure of 20 N/mm^2 determine:
 - i. The magnitude and the direction of the torque applied on the crankshaft.
 - ii. Net force on the piston.
 - iii. The thrust in the connecting rod.
 - iv. The thrust on the sides of cylinder walls.
- (b) Discuss D' Alembert principle.

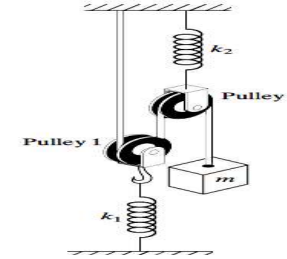
9 + 3 = 12

- 3. (a) Determine the torsional spring constant of the steel propeller shaft shown in Figure below.



2

- (b) Determine the natural frequency of the system shown in Figure below. Assume the pulleys to be frictionless and of negligible mass.



5 + 7 = 12

Group - C

- 4. (a) A machine weighs 18 kg and is supported on springs and dashpots. The total stiffness of the springs is 12 N/mm and the damping is 0.2 N/mm/s . The system is initially at rest and a velocity of 120 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 0.4 second.

- (b) Write a detailed note on 'Vibration Isolation and Transmissibility'.

8 + 4 = 12

- 5. (a) A shaft of 50 mm diameter and 3-meter length has a mass of 15 kg per meter length. It is simply supported at the ends and carries three masses of 120 kg, 180 kg and 80 kg at 0.8m, 1.5 m and 2.6 m respectively from the left support. Taking $E = 200 \text{ GN/mm}^2$ find the fundamental frequency of transverse vibration of the shaft.
- (b) Write a detailed note on whirling of a shaft.

7 + 5 = 12

Group - D

- 6. (a) The following data refers to two-cylinder locomotive with cranks at 120° . Reciprocating mass per cylinder = 300 kg, Crank radius = 0.3 m, Driving wheel diameter = 2 m, Distance between cylinder centre lines = 0.8 m, Distance between the driving wheel central planes = 1.6m. Determine
 - i. The fraction of reciprocating masses to be balanced, if the hammer blow is not to exceed 50 kN at 100 km/h.
 - ii. The variation of tractive force
 - iii. The maximum swaying couple.

- (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.

7 + 5 = 12