



- Q.3 Derive an expression the primary and secondary forces of Balancing of V-engines. (10)

OR

A shaft has three eccentrics, each 75 mm diameter and 25 mm thick, machined on one piece with the shaft. The central planes of the eccentric are 60 mm apart. The distance of the centres from the axis of rotation are 12 mm, 18 mm and 12 mm and their angular positions are  $120^\circ$  apart. The density of metal is  $7000 \text{ kg/m}^3$ . Find the amount of out-of-balance force and couple at 600 r.p.m. If the shaft is balanced by adding two masses at a radius 75 mm and at distances of 100 mm from the central plane of the middle eccentric, find the amount of the masses and their angular positions.

- Q.4 In a spring loaded governor of the Hartnell type, the mass of each mass is 1 kg, length of vertical arm of the bell crank lever is 100 mm and that of the horizontal arm is 50 mm. The distance of fulcrum of each bell crank lever is 80 mm from the axis of rotation of the governor. The extreme radii rotation of the bells are 75 mm and 112.5 mm. The maximum equilibrium speed is 5% greater than the minimum equilibrium speed which is 360 rpm. Find, neglecting obliquity of arms, initial compression of the spring and equilibrium speed corresponding speed to the radius of rotation of 100 mm. (10)

OR

The upper arms of a Porter governor are pivoted on the axis of rotation, their lengths being 30 cm. the lower are pivoted on the sleeve at a distance of 3 cm from the axis, their lengths being 27 cm. Mass of each ball is 6 kg and the sleeve mass is 50 kg. Determine the equilibrium speed for a radius of rotation of 17 cm and also the effort and power for 1% change of speed. (10)

- Q.5 A cam drive a flat reciprocating follower in the following manner: (10)  
During first  $120^\circ$  rotation of the cam, follower moves outwards through a distance of 20 mm with simple harmonic motion. The follower dwells during next  $30^\circ$  of cam rotation. During next  $120^\circ$  of cam rotation. The follower moves inwards with simple harmonic motion. The follower dwells for the next  $90^\circ$  of the rotation.  
The minimum radius of the cam is 25 mm. Draw the profile of the cam.

OR

Draw the displacement velocity and acceleration diagram for a follower when it moves with uniform acceleration and retardation. Derive the expression for velocity and acceleration during outstroke and return stroke of the follower.

- Q.6 The turbine rotor of a ship having a mass of 200 kg rotates at 2000 r.p.m and its radius of gyration is 0.30 m. If the rotation of the rotor is clockwise looking from the aft, determine the gyroscopic couple set by the rotor when (10)  
i) Ship takes a left hand turn at a radius of 300 meters at a speed of 30 km/hr,  
ii) Ship pitches with the bow rising at an angular velocity of 1 rad/sec. and  
iii) Ship rolls at an angular velocity of 0.1 rad/sec.

OR

A two wheeler vehicle and its rider together weigh 2.2 kN and their combined centre of gravity is 600 mm above the ground level when the vehicle upright. Each road wheel of 600 mm diameter and has a moment of inertia of  $10 \text{ Nm}^2$ . The rotating parts of the engine have a moment of inertia of  $1.7 \text{ Nm}^2$ . The engine rotates at 5.5 times the speed of the road wheels and in the same sense. Determine the angle of heel necessary when the vehicle is rounding a curve of 30 m radius at a speed of 55 Km/hr. (10)