

9. A Hartnell governor is a
- (a) Pendulum type governor (b) spring loaded governor
(c) Dead weight governor (d) inertia governor
10. The engine of an aeroplane rotates in clockwise direction when seen from the tail end and the aeroplane takes a turn to the left. The effect of the gyroscopic couple on the aeroplane will be
- (a) To raise the nose and dip the tail (b) To dip the nose and raise the tail
(c) To raise the nose and tail (d) To dip the nose and tail

PART B (10 x 2=20 Marks)

11. State D'Alemberts principle.
12. Define coefficient of fluctuation of energy.
13. State the conditions for static and dynamic balancing.
14. What are different types of balancing machines?
15. What are the different types of vibrations?
16. Define critical or whirling speed.
17. Define logarithmic decrement.
18. Define transmissibility.
19. How governors are classified?
20. Give application of gyroscopic principle.

PART C (5 x 14 = 70 Marks)

21. a) A vertical petrol engine 100 mm diameter and 120 mm stroke has a connecting rod 250 mm long. The mass of the piston is 1.1 kg. The speed is 2000 r.p.m. On the expansion stroke with a crank 20° from top dead centre, the gas pressure is 700kN/m^2 . Determine: 1. Net force on the piston, 2. Resultant load on the gudgeon pin, 3. Thrust on the cylinder walls, and 4. Speed above which, other things remaining same, the gudgeon pin load would be reversed in direction.

(OR)

- b) The turning moment diagram for a multi cylinder engine has been drawn to a scale $1\text{mm} = 600\text{ N-m}$ vertically and $1\text{ mm} = 3^\circ$ horizontally. The intercepted areas between the output torque curve and the mean resistance line, taken in order from one end, are as follows : + 52, - 124, + 92, - 140, + 85, - 72 and + 107 mm^2 , when the engine is running at a speed of 600 rpm. If the total fluctuation of speed is not to exceed $\pm 1.5\%$ of the mean, find the necessary mass of the flywheel of radius 0.5 m.

22. a) A shaft carries four masses in parallel planes A, B, C and D in this order along its length. The masses at B and C are 18 kg and 12.5 kg respectively, and each has an eccentricity of 60 mm. The masses at A and D have an eccentricity of 80 mm. The angle between the masses at B and C is 100° and that between the masses at B and A is 190° , both being measured in the same direction. The axial distance between the planes A and B is 100 mm and that between B and C is 200 mm. If the shaft is in complete dynamic balance, determine : 1. The magnitude of the masses at A and D 2. The distance between planes A and D and 3. The angular position of the mass at D.

(OR)

- b) Four masses m_1 , m_2 , m_3 and m_4 are 200 kg, 300 kg, 240 kg and 260 kg respectively. The corresponding radii of rotation are 0.2 m, 0.15 m, 0.25 m and 0.3 m respectively and the angles between successive masses are 45° , 75° and 135° . Find the position and magnitude of the balance mass required, if its radius of rotation is 0.2 m.
23. 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: 1. the resistance of the dashpot at unit velocity ; 2. the ratio of the frequency of the damped vibration to the frequency of the undamped vibration ; and 3. the periodic time of the damped vibration.

(OR)

- b) A steel shaft 1.5 m long is 95mm in diameter for first 0.6m of its length, 60mm in diameter for 0.5m of the length and 50mm in diameter for the remaining 0.4m length. The shaft carries two flywheels at two ends, the first having a mass of 900kg and 0.85m radius of gyration located at the 95mm diameter end and the second having a mass of 700kg and 0.55m 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 80GN/m^2 .
24. a) A mass of 10 kg is suspended from one end of a helical spring, the other end being fixed. The stiffness of the spring is 10 N/mm. The viscous damping causes the amplitude to decrease to one-tenth of the initial value in four complete oscillations. If a periodic force of $150\cos 50t$ N is applied at the mass in the vertical direction, find the amplitude of the forced vibrations. What is its value of resonance?

(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 rpm. and less than this at all higher speeds. 1. Find the necessary stiffness of the elastic support, and the amplitude of vibration at 800 rpm, and 2. If the engine speed is reduced below 800 rpm, at what speed will the transmitted force again becomes 600 N?

25. a) A governor of the Proell type has each arm 250 mm long. The pivots of the upper and lower arms are 25 mm from the axis. The central load acting on the sleeve has a mass of 25 kg and the each rotating ball has a mass of 3.2 kg. When the governor sleeve is in mid-position, the extension link of the lower arm is vertical and the radius of the path of rotation of the masses is 175 mm. The vertical height of the governor is 200 mm. If the governor speed is 160 rpm, when in mid-position, find: 1. length of the extension link; and 2. tension in the upper arm.

(OR)

- b) The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45 m and a speed of 3000 rpm clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship: 1. when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h. 2. When the ship is pitching in a simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12 degrees.
