THEORY OF MACHINE AND MECHANISM II

TUTORIAL NO: 4

GOVERNORS

1. The length of the upper arm of a Watt governor is 400 mm and its inclination to the vertical is 30°. Find the percentage increase in speed, if the balls rise by 20 mm.

2. A Porter governor has equal arms, each 250 mm long and pivoted on the axis of rotation. Each ball has a mass of 5 kg and mass of the central load is 25 kg. The radius of rotation of the ball is 150 mm when the governor begins to lift and 200 mm when the governor is at maximum speed. Determine the maximum speed and range of speed of the governor.

3. The lower arms are pivoted to the sleeve at a distance of 30 mm from the axis of rotation. The length of the upper arms is 280 mm and that of the lower arms is 300 mm. The mass of each ball is 6 kg. If the equilibrium speed is 200 rpm, when the radius of rotation is 200 mm, determine the required mass of the sleeve.

4. A Porter governor has all four arms 250 mm long. The upper arms are attached on the axis of rotation and the lower arms are attached to the sleeve at a distance of 30 mm from the axis. The mass of each ball is 5 kg and the sleeve has a mass of 50 kg. The extreme radii of rotation are 150 mm and 200 mm. Determine the range of speed of the governor.

5. In a Porter governor the upper and lower arms are each 25 cm long and they are attached on points on the governor spindle. On bottom position of the sleeve, the arms make an angle of 35^0 with the vertical spindle and in top position the angle is 45^0. If the weight of each rotating ball is one-eighth of the central load, find the speed range of the governor.

6. A Proell governor has arms of 300 mm length. The upper arms are hinged on the axis of rotation, whereas the lower arms are pivoted at a distance of 35 mm from the axis of rotation. The extensions of lower arms to which the balls are attached are 100 mm long. The mass of each ball is 8 kg and the mass on the sleeve is 60 kg. At the minimum radius of rotation of 200 mm, the extensions are parallel to the governor axis. Determine the equilibrium speed of the governor for the given configuration. What will be the equilibrium speed for the maximum radius of 250 mm?

7. In a Hartnell Governor, the mass of each rotating ball is 2kg. The bal arm is 125 mm long and the sleeve arm is 75 mm. When the ball arm is vertical, the radius of rotation is 100 mm and the equilibrium speed is 250 rpm. An increase of 8 % in speed results in sleeve movement of 12 mm. Determine the stiffness of the spring and the initial spring load.

8. In a Wilson-Hartnell type governor, the mass of each ball is 5 kg. The length of the ball arm and sleeve arm of each bell crank lever are 100 mm and 80 mm respectively. The stiffness of each of the two springs attached directly to the balls is 0.3 kN/m. The lever for the auxiliary spring is pivoted at its mid point. When radius of rotation is 100 mm, the equilibrium speed is 200 rpm. If the sleeve is lifted by 8 mm for an increase of sped of 6 %. Determine the required stiffness of the auxiliary spring.

9. A hartung governor has a rotating mass of 4 kg and a spring of stifness 10 kN/m in compression. In the mid position, the compression each spring is 60 mm and the radius of rotation is 160 mm. The wieght of the sleeve and the load due to gear operated governor is 20 kg at the sleeve. If the vertical arm is 130 mm long and the horizontal arm is 150 mm long, determine the equilibrium speed fro the given mid position.

10. A Pickering Governor is used in a gramophone has three leaf springs of cross section 2.5 mm × 0.2 mm and length of 40 mm. On center of each leaf, a mass of 20 g is attached. The distance between the spindle axis and the mass at rest is 11 mm. Determine the equilibrium speed of the turntable. The turntable rotates at 1/8 th speed of the governor. The lift of the sleeve is 0.5 mm. Assume $E = 2 \times 10^{11}$ N/m^2.

ANSWERS

1. 2.7674 %
2. 189.163 rpm, 25.343 rpm
3. 46.373 kg
4. 30.015 rpm
5. 15.13 rpm
6. 144.095 rpm, 156.800 rpm
7. 15.217 kN/m, 456.93 N
8. 12.422 kN/m
9. 318.775 rpm
10. 121.69 rpm