GOVERNOR

1) A porter governor has all four arms of 30 cm each. All the upper arms as well as the sleeve arms are pivoted on the axis of rotation. The mass of each ball is 1 kg. The mass on the sleeve is 20 kg. Find the speed of rotation when the balls rotate at a radius of 15 cm. **[268.97 rpm]**

2) The arms of porter governor are 25 cm long and pivoted on the governor axis. Mass of each ball is 5 kg and mass of central sleeve is 30 kg. The radius of rotation of the ball is 15 cm when the sleeve begins to rise and reaches a value of 20 cm for maximum speed. Determine the range of the governor. **[27.38 rpm]**

3) The lengths of upper and lower arms of a porter governor are 20 cm and 25 cm. both the arms are pivoted on the axis of rotation. The central load is 150 N, the weight of each ball is 20 N and the friction on the sleeve together with the resistance of the operating gear is equivalent to a force of 30 N at the sleeve. If the limiting inclinations of the upper arms to the vertical are 30^0 and 40^0. Determine the range of speed of the governor. **[45.85 rpm]**

4) A porter governor has 4 links each 25 cm long, 2 revolving masses each weight 30 N and central dead weight 200 N. all the links are attached to respective sleeves at radial distance of 4 cm from the axis the rotation. The masses revolve at a radius of 15 cm at minimum speed and at a radius of 20 cm at maximum speed. Determine the range of speed. **[19.33 rpm]**

5) The upper arms of a porter governor are pivoted on the axis of rotation and the lower arms are attached to the sleeve at a distance of 3.76 cm from the axis. The lengths of the arms and suspension links are 30 cm. the weight of each ball is 60 N and the load on the sleeve is 480 N. if the extreme radii of rotation of governor balls are 20 cm and 25 cm, find the corresponding equilibrium speed. **[177.8 rpm, 203.27 rpm]**

6) The arms of the porter governor are 17.8 cm long are hinged at a distance of 3.8 cm from the axis of rotation. The balls weight 1.15 kg each and the weight on the sleeve is 20 kg. The governor sleeve begins to rise to 280 rpm when the links are at angle of 30^0 to the vertical. Determine the higher and lower speeds when arms are inclined at 45^0 ti the vertical, assuming the friction to be constant. Calculate detention by friction at the second position. **[15.4 rpm]**

7) A porter governor has equal arms and links each 250 mm long. The mass of each ball is 2 kg and the central mass is 12 kg. When the ball radius is 150 mm, the valve is fully open and when the radius is 185 mm the valve is fully closed. Find the maximum speed and range of speed. If the maximum speed is increased 20% by an addition of mass to the central load. Find what addition mass is required. **[16.03 rpm, 6.15 kg.]**

i) A porter governor, the lengths of upper and lower arms 200 mm and 250 mm. each ball weight is 3 kg and central load is 22.5 kg. For lowest and highest position of the sleeve, the arms are at inclined 30^0 and 40^0 to the vertical. The friction at the governor and the mechanism connected to it the value is equivalent to 45 N at the sleeve. Assuming that the links and arms intersect on the axis, find **i)** Travel of the sleeve **ii)** Range of speed of governor. **[19.99 mm & 46.35 rpm]**

8) The arms of Proell governor are 28 cm long. The upper arm pivoted on the axis of rotation, while the lower arms are pivoted to the sleeve at a distance 4 cm from the axis of rotation. Each ball has a mass of 5.5 kg and is carried on an extension of 10 cm long of the lower arm. The central load is 90 kg. The extension of the lower arms to which the balls are attached Are parallel to the governor axis when the radius of rotation is 20 cm. find…

i) Equilibrium speed for the above configuration **[216.51 rpm]**

ii) Equilibrium speed for the radius of rotation of 23 cm. **[226.55 rpm]**

9) A proell governor has arms of 300 mm length. The upper arms are pivoted on the axis of rotation, where as the lower arm pivoted at a distance of 35 mm from the axis of rotation. The extensions of the lower arm to which balls are attached are 100 mm long. The mass of each ball is 8 kg and mass of sleeve is 60 kg. At the minimum radius of rotation of 200 mm, the extension is parallel to the governor axis. Determine the equilibrium speed of the governor for the given configuration what will be the equilibrium speed for maximum radius of 250 mm.

10) For a hartnell governor mass of the balls 1.8 kg, length of the vertical arm and other arm of bell crank lever are 8.75 cm and 10 cm. the speeds corresponding to radii of rotations of 12 cm and 13 cm are 296 rpm & 304 rpm. Determine the stiffness of the spring. **[4546.5 N/m]**

11) In a hartnell governor , the lengths of ball and sleeve arms of a bell crank lever are 120 mm and 100 mm. the distance of the fulcrum of the bell crank lever from the governor axis is 140 mm. each governor ball has a mass of 4 kg. the governor runs at a mean speed of 300 rpm with the ball arms vertical and sleeve arms horizontal. For An increase of speed 4%, the sleeve moves 10 mm upwards. Neglecting friction-

i) The minimum speed if the total sleeve movement is limited to 20 mm **[285.53 rpm]**

ii) The spring stiffness **[22933 N/m]**
iii) The sensitiveness of governor **[11.3]**
iv) The spring stiffness if the governor is to be isochronous at 300 rpm **[11372.4 N/m]**

12) In a Hartnell governor, running at 500 rpm have a radius of rotation of 7 cm with sleeve in mid position and ball arms vertical. The ball arm length and sleeve arm length are equal. The maximum sleeve movement is 2 cm with ± 5% variation in speed. the mass of the sleeve is 6 kg and friction may be assumed to be equivalent of an additional load of 25 N at the sleeve. The governor effort is sufficient to overcome the friction at the sleeve by 1% change of speed at the midpoint. Determine –

i) Mass of each ball **[3.28 kg]**
ii) Spring rate **[28.12 N/mm]**
iii) Initial compression of spring **[0.0334 m]**
iv) Governor efforts for 1% change of speed **[12.8 N]**
v) Governor power **[0.256 Nm]**

13) In a hartnell governor the two masses are 4 kg and the load on the sleeve is 40 N. if with the weight arms vertical, the path radius is 8 cm and the equilibrium speed neglecting friction 420 rpm, find the corresponding compression force in the spring. Find also the friction force at the sleeve which can be overcome in this position for an increase in speed of 1%. If the sleeve movement is to be 1 cm for increase in speed of 5% from the 420 rpm position, find the required spring stiffness, if gravity effect on the masses is neglected. **[1196.8 N, 24.84 N & 24752 N/m]**

14) In hartnell governor, the mass of each ball 1.5 kg; length of bell crank lever arms, a= 10 cm & b= 5 cm; distance of the fulcrum of the each bell crank lever from the axis of rotation 8 cm; minimum and maximum radii of rotation of the balls 7 cm & 11 cm. the maximum equilibrium speed is 350 rpm and minimum equilibrium speed is 10% less than this. Estimate the stiffness of the governor spring, a is the length of the ball arm and b of the roller arm. **[21478 N/m]**

15) The arms of hartnell governor are of equal length. At the mid position of the sleeve, the ball arm is vertical and the radius at which the ball rotates is 8.25 cm when the equilibrium speed, neglecting friction, is 450 rpm. On changing the speed by 1%, the governor is able to overcome the friction at this position. The friction force is assumed to have constant value of 30 N at the sleeve. The sleeves moves ±1.6 cm from the mean position. The minimum speed of the governor including friction is 428 rpm. The mass of the sleeve is 3.5 kg. determine –

i) The magnitude of the rotating masses **[4.1 kg]**
ii) The spring stiffness **[23684.9 N/m]**
iii) The initial compression of the spring **[0.046 m]**
iv) The maximum speed

16) The total sleeve movement of the spring controlled hartnell governor is 3 cm. the mass of the rotating ball is 1.35 kg each at the mid position of the sleeve, the sleeve arm, which is 6.25 cm long, is horizontal. The ball arm has a length of 7.5 cm. at the mid position of the sleeve, the balls rotate at a radius of 10 cm. due to maladjustment of the spring, the equilibrium governor speed at the topmost position of the sleeve is 420 rpm and to the lowest position of the sleeve is 435 rpm. Determine-

i) The stiffness and initial compression of the spring **[0.088 m]**
ii) The required initial compression of the spring to given an equilibrium speed at the topmost position which is 12 rpm more than that at the lowest position. Neglect the moment due to the weight of the ball **[5.6 cm]**

17) In a hartnell governor, mass of each ball is 6.8 kg and moves radially under the action of a controlling force $\boldsymbol{F = a + b.r}$, where 'r' is the ball path radius. If the speed range is 42.5 to 44.0 radian per sec. and the corrospoding values of ; r = 12.38 cm & 13.01 cm, obtains the values of 'a' and 'b'. find the equilibrium speed in rad/sec for ; r = 12.7 cm

[a = -2255.72 & b = 30503.17 and 43.28 rad/sec]

18) In a hartnell governor, the radius of ball is 60 mm at the minimum speed of 300 rpm. The length of the ball arm is 140 mm and the sleeve arm is 90 mm. the mass of each ball is 5 kg and sleeve is 8 kg. the stiffness of the spring is 32715 n/m. determine –

i) Speed when the sleeve is lifted by 50 mm
ii) Initial compression of the spring
iii) Governor effort
iv) Power

19) In a proell governor the mass of each ball is 8 kg and mass of sleeve is 120 kg. Each arm is 180 mm long. The length of extension of lower arms to which the balls are attached is 80 mm. the distance of pivots of arms from axis of rotation is 30 mm and the radius of rotation of the balls is 160 mm. when the arms are inclined at 45^0 to the axis of rotation. determine-

i) Equilibrium speed

ii) Coefficient of insensitiveness if the friction of the mechanism is equivalent to 30 N.

iii) The range of speed when governor is inoperative.

20) In a hartnell governor, the mass of each ball is 4 kg and lift of sleeve is 40 mm. the governor begins to float at 200 rpm. When the radius of ball path is 90 mm. the mean working speed of the governor is 16 times the range of speed when friction is neglected. The lengths of the balls and roller arms of the bell crank lever are 100 mm and 80 mm. the pivot center and axis of the governor are 115 mm apart. Determine the initial compression of the spring taking into account the obliquity all arms. Assuming the friction at the sleeve to be equivalent to a force of 15 N, determine the total alteration in speed before the sleeve begins to move from the mid position. **[51.3 mm & 5.7 rpm]**

21) The upper arms of a porter governor have lengths 350 mm and are pivoted on the axis of rotation. The lower arms have lengths 300 mm and are attached to the sleeve at a distance of 40 mm from the axis. Each ball has a mass of 4 kg and mass on the sleeve is 45 kg. Determine the equilibrium speed for a radius of rotation of 200 mm and find also the effort 7 power of the governor for 1% speed change. **[191 rpm, 4.8 N & 52 Nmm]**

22) In a hartnell governor , the length of balls and sleeve arms of a bell crank lever are 120 mm & 100 mm. the distance of a fulcrum of the bell crank lever from the axis is 140 mm. each governor ball has a mass of 4 kg. The governor runs at a mean speed of 300 rpm with the ball arms vertical and sleeve arms horizontals. For an increase of speed of 4%, the sleeve moves 10 mm upwards. Neglecting friction, find

i) The minimum speed if the total sleeve movement is limited to 20 mm **[285.4 rpm]**

ii) The spring stiffness **[23.28 N/mm]**

iii) The sensitiveness of the governor **[8.9%]**

iv) The spring stiffness if the governor is to be isochronous at 300 rpm **[11.35 N/mm]**

23) The controlling force (Fc) in Newtons and the radius of rotation (r) in meters for a spring controlled governor is given by the expression

$$Fc = 2800\,r - 76$$

The mass of the ball is 5 kg each and extreme radii of rotation of the balls are 100 mm & 175 mm. find the maximum and minimum speeds of equilibrium. If the friction of the governor mechanism is equivalent to a force of 5 N at each ball, find the coefficient insensitiveness of the governor at the extreme radii. **[192.6 rpm, 207.6 rpm & 9.4%]**

24) The following for a portor governor, all the arms of governor are 178 mm long and hinged at a distance of 38 mm from the axis of rotation. The mass of each ball is 1.15 kg and mass of sleeve is 20 kg. The governor sleeve begins to rise at 280 rpm, when the links are at angle of 30^0 to the vertical. Assuming the frictional force to be constant, determine the minimum and maximum speeds of rotation when the inclination of arm to the vertical is 45^0. **[309 rpm & 324 rpm]**

25) The following particulars refer to a proell governor with open arms. Length of all arms equal to 200 mm distance of pivot of arms of rotation is 40 mm, length of extension of lower arms to which each ball is attached is 100 mm, mass of each ball is 6 kg and the mass of central load is 150 kg. if the radius of rotation of the balls is 180 mm when the arms are inclined at an angle of 40^0 to the axis of rotation, find the equilibrium speed for the above configuration. **[256.04 rpm]**

26) In a spring loaded governor of hartnell type, the mass of each ball is 1 kg, length of vertical arm of the bell crank lever is 100 mm and that of horizontal arm is 50 mm. the distance of fulcrum or each bell crank lever is 80 mm from the axis of rotation of the governor. The extreme radii of rotation of the balls 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 to the radius of rotation of 100 mm. **[28.6 mm & 375 rpm]**

27) The lengths of the upper arms of a portor governor are 20 cm & 25 cm. both the arms are pivoted on the axis of rotation. The central load is 150 n, the weight of each ball is 20 N and the friction of the sleeve together with the resistance of the operating gear is equivalent to a force of 30 n at the sleeve. If the limiting inclinations of the upper arms to the vertical are 30^0 and 40^0. Determine the range of speed of the governor. **[45.99]**

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