

**UNIT-V (GOVERNOR AND GYROSCOPE)**

**PART-A (2 marks)**

1. What is the function of governor? **AU2003, AU2005, AUA/M2011**
2. How governors are classified? **AU2004, AU M/J 2006**
3. Differentiate between governors and fly wheel. **AU2003, AUN/D2009, AUA/M2011, AUN/D2011, AUA/M2015**
4. What is meant by applied torque and reaction torque? **AUM/J2012**
5. What is meant by sensitiveness of a governor? **AU2004, AU2006, AUM/J2012, AUN/D2013, AUN/D2014**
6. What is the effect of friction on the governor? **AU2004, AUN/D2005**
7. What is meant by hunting? **AU N/D 2006, AUN/D2007, AUN/D2009, AUN/D2012**
8. What is meant by isochronous conditions governor? **AU2006, AU2007, AUN/D2010, AUM/J2013**
9. Differentiate between isochronous governor and sensitiveness of a governor. **AUM/J2014**
10. Define the meaning of stability of a governor. **AUN/D2008, AUM/J2009, AUN/D2011**
11. What is gyroscopic torque? **AU2003, AUN/D2005, AUN/D2008**
12. What is the effect of gyroscopic couple on rolling of ship? Why? **AU2007**
13. Define gyroscope. **AU M/J 2006**
14. What is meant by reactive gyroscopic couple? **AUM/J2014**
15. Define gyroscopic couple. **AU2004, AU2005, AU2006, AUM/J2009, AUA/M2011**
16. Write expression for gyroscopic couple. **AUN/D2007, AUA/M2011**
17. What is the effect of gyroscopic couple on an automobile taking a turn? **AUN/D2012, AUN/D2014**
18. Distinguish between pitching and rolling motion of ships. **AUN/D2010**
19. What will be the effect of gyroscopic couple on a disc fixed at a certain angle to a rotating shaft? **AUM/J2013**
20. List some of the terms related to motion of ships using gyroscopic principle. **AUN/D2013, AUA/M2015**

**PART-B (GOVERNOR AND GYROSCOPE)**

1. A spring loaded governor of the Hartnell type has equal arms. The balls rotate in a circle of 15 cm dia when the sleeve is in the mid position and the ball arms are vertical. The equilibrium speed for this position is 500 rpm. The maximum sleeve movement is to be 3 cm and the maximum variation of speed taking in account the friction to be of the mid position speed. The mass of the sleeve is 5 kg and the friction force may be consideration to arise out of an equivalent to 3 kg at the sleeve. The power of the governor must be sufficient to overcome the friction by  $\pm 1\%$  change of speed either way at mid-position. Determine 1. The rotating mass: 2. the spring stiffness 3. the initial compression of spring. Neglect obliquity effect of arms. **AUA/M2015**
2. The driving axle of a locomotive with two wheels has a mass moment of inertia of  $350 \text{ kg m}^2$ . The wheels are 1.8 m diameter. The distance between the planes of the wheels is 1.5m. When travelling at 100 km/hr the locomotive passes over a defective rail which causes the right hand wheel to fall 10 mm and rise again in a total time of 0.1 sec, the vertical movement of the wheel being with SHM. Find the maximum gyroscopic torque caused. Determine the direction in which it acts when the wheel is failing. Let the linear motion of the right hand wheel be  $\alpha \cos qt$ . where  $\alpha=0.005\text{m}$  and  $q=2\pi/0.1 \text{ rad/sec}$ . **AUA/M2006,AUA/M2015**
3. In an engine governor of the Porter type, the upper and lower arms are 200mm and 250 mm respectively and pivoted on the axis of rotation. The mass of the central load is 15 kg, the mass of each ball is 2 kg and friction of the sleeve together with the resistance of the operating gear is equal to a load of 25 N at the sleeve. If the limiting inclinations of the upper arms to the vertical are  $30^\circ$  and  $40^\circ$ , Find, taking friction into account, range of speed of the governor. **AUN/D2014**
4. Explain the effect of the gyroscopic couple on the reaction of the four wheels of a vehicle neglecting a curve. **AUN/D2014**
5. The radius of rotation of the balls of a Hartnell governor is 80 mm at the minimum speed of 300 r.p.m. Neglecting gravity effect, determine the speed after the sleeve has lifted by 60 mm. Also determine the initial compression of the spring, the governor effort and the power. The particulars of the governor are given below: Length of ball arm = 150mm; length of sleeve arm = 100mm; mass of each ball = 4 kg; and stiffness of the spring = 25 N/mm. **AUM/J2014**
6. 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 r.p.m. 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. **AUM/J2013, AUM/J2014**

7. A porter governor has equal arms each 250mm long and pivoted on the axis of rotation. Each ball has a mass of 5kg and mass of the central load on the sleeve is 25kg. The radius of rotation of the ball is 150mm when governor begins to lift and 200mm when the governor is at maximum speed. Find the maximum and minimum speed and range of speed of the governor. (16) **AUN/D2007, AUM/J2011**
8. Calculate the range of speed of a porter governor which has equal arms of each 200mm long and pivoted on the axis of rotation. The mass of each ball is 4kg and the central load of the sleeve is 20kg. The radius of rotation of the ball is 100mm when the governor begins to lift and 130mm when the governor is at maximum speed. **AUM/J2009**
9. A porter governor has equal arms each 250mm long. The upper arms are attached on the axis of rotation and the lower are attached to sleeve at a distance of 30mm from the axis. Each ball has a mass of 5kg and mass of the central load on the sleeve is 50kg. The radius of rotation of the ball is 150mm when governor begins to lift and 200mm when the governor is at maximum speed. Find the maximum and minimum speed and range of speed of the governor. (16) **AUA/M2011**
10. A porter governor has equal arms each 250mm long. The upper arms are attached to sleeve at a distance of 40mm and the lower are attached to sleeve at a distance of 50mm from the axis. Each ball has a mass of 2.5kg and mass of the central load on the sleeve is 25kg. The force of friction on the sleeve is 20N. The radius of rotation of the ball is 125mm when governor begins to lift and 150mm when the governor is at maximum speed. Find the maximum and minimum speed and range of speed of the governor. (16) **AUN/D2010**
11. A hartnell governor having a central sleeve spring and two right angled bell crank lever operates between 290rpm and 310rpm for a sleeve lift of 15mm. The sleeve and ball arms are 80mm and 120mm respectively. The levers are pivoted at 120mm from the governor axis and mass of the ball is 2.5kg. The ball arms are parallel at lowest equilibrium speed. Determine (i) load on the spring at maximum and minimum speeds and (ii) Stiffness of the spring. (16) **AUN/D2005**
12. The controlling force in a spring controlled governor is 1500N when radius of rotation is 200mm and 887.5N when radius of rotation is 130mm. The mass of each ball is 8kg. If the controlling force curve is a straight line, then find (i) Controlling force at 150mm radius of rotation (ii) Speed of the governor at 150mm radius. (iii) Increase in initial tension so that governor is isochronous. (iv) Isochronous speed. (16) **AUM/J2006**

13. In a spring controlled governor, the controlling force curve is a straight line. When the balls are 400mm apart, the controlling force is 1200N and when 200mm apart, the controlling force is 450N. Determine the speed at which the governor runs when the balls are 250mm apart. When initial tension on the spring would be required for isochronisms and what would be the speed. Take mass of each ball to be 10kg. (16) **AUN/D2006**
14. Calculate the range of speed of a proell governor, which has equal arms each of 300mm and are provided on the axis of rotation. The mass of each ball is 10kg and the central mass on the sleeve is 100kg. The extension arms of the lower links are each 80mm long and parallel to the axis when the radius of rotation of the balls are 150mm and 200mm. (16) **AUM/J2013**
15. The rotor of a turbine yacht rotates at 1200rpm clockwise when viewed from stern. The rotor has a mass of 750 kg and radius of gyration of 250mm. Find the maximum gyroscopic couple transmitted to the hull when yacht pitches with a maximum angular velocity of 1 rad/s. What is the effect of this couple? (16) **AUN/D2005**
16. (i) Explain the effect of Gyroscopic couple on a Naval ship during pitching. (8)  
(ii) Explain the effect of gyroscopic couple on a Aero plane. (8)
17. Each paddle wheel of a steamer have a mass of 1600kg and a radius of gyration of 1.2meters. The steamer turns to port in a circle of 160meters radius at 24Km/hr. The speed of the paddle is 90rpm. Find the magnitude and effect of the gyroscopic couple acting on the steamer. (16)
18. The turbine rotor of a ship has a mass of 20 tones and a radius of gyration 0.75. Its speed is 2000rpm. The ship pitches  $6^\circ$  above and below the horizontal position. One complete oscillation takes 18 seconds and the motion is simple harmonic. Determine (i) the maximum couple tending to shear the holding down bolt of the turbine  
(ii) The maximum angular acceleration of the ship during pitching  
(iii) The direction in which the bow will tend to turn while, if the rotation of the rotor is clockwise when looking from rear. (16)