2. A centrifugal fan of mass 5kg has a rotating unbalance of 0.25kgm. When dampers having damping factor of 0.2 are used, specify the springs for mounting such that only 10% of the unbalance force is transmitted to the floor. The fan is running at a constant speed of 100 rpm. **(APR/MAY 17)**

3. A machine has a total mass of 90kg and unbalanced reciprocating parts of mass 2kg which moves through a vertical stroke of 100mm with simple harmonic motion. The machine is mounted on four springs. The machine is having only one degree of freedom and can undergo vertical displacement only. Calculate (i) the combined stiffness of the springs if the force transmitted to the foundation is one-thirteenth of the applied force. Neglect damping and take the speed of rotation of the machine crank shaft as 1000 rpm. When the machine is actually supported on the springs, it is found that the damping reduces the amplitude of the successive free vibrations by 30%. Find (i) the force transmitted to the foundations at 900 rpm. **(NOV/DEC 15)**

4.A compressor supported symmetrically on four springs has a total mass of 100kg. The mass of the reciprocating parts is 2kg which moves through a vertical stroke of 80mm withSHM. Neglecting damping, determine the combined stiffness of the springs so that the force transmitted to the foundation is $1/25^{th}$ of the impressed force. The machine crank shaft rotates at 1000rpm. When the compressor is actually supported on the springs, it is found that the damping reduces the amplitude of the successive free vibrations by 25%. Find the force transmitted to the foundations at 1000 rpm, the force transmittedto the foundation at resonance and the amplitude of the vibrations at resonance. **(NOV/DEC 17)**

5.A machine supported symmetrically on four springs has a mass of 80 kg. The mass of the reciprocating parts is 2.2 kg which move through a vertical stroke of 100 mm with simple harmonic motion. Neglecting damping, determine the combined stiffness of the springs o that the force transmitted to foundation is$1/20^{th}$of the impresses force. The machine crankshaft rotates at 800 rpm. If under working conditions, the damping reduces the amplitudes of successive vibrations By 30%,find(i)the force transmitted to the foundation at resonance and(ii)the amplitude of vibration at resonance. **AUM/J2009, AUN/D2009, AUN/D2008**

6. Find the stiffness of each spring when a refrigerator unit having a mass of 30kg is to be support by three springs. The force transmitted to the supporting structure is only 10%of the impressed force. The refrigerator unit operates at 420rpm. **AUN/D2005**

7. A 1000kg machine is mounted on four identical springs of total spring constant K and having negligible damping. The machine is subjected to a harmonic external force amplitude F_o = 490N and frequency 180rpm. Determine the amplitude of motion of the machine and the maximum forced transmitted to the foundation because of the unbalanced force when K = 1.96 x 10^6 N/m. **(NOV/DEC 18)**

GYROSCOPE

1. The mass of the turbine rotor of a ship is 20 tonnes and has a radius of gyration of 0.6m. Its speed is 2000 rpm. The ship pitches 6° above and 6° below the horizontal position. A complete oscillation takes 30 seconds and the motion is simple harmonic. Determine the following: 1) Maximum gyroscopic couple, 2) Maximum angular acceleration of the ship during pitching, and 3) The direction in which the bow will tend to turn when rising, if the rotation of the rotor is clockwise when looking from the left.**(APR/MAY 18)**

2. The turbine rotor of a ship has 2.4 tonnes and rotates at 1750rpm clockwise when viewed from the aft. The radius of gyration of the rotor is 300mm. Determine the gyroscopic couple and its effect when: (i) the ship turns right at a radius of 250mm with a speed of 22 kmph (ii) the ship pitches with the bow rising at an angular velocity of 0.85 rad/s, and (iii) the ship rolls with angular velocity of 0.15 rad/s.

(NOV/DEC 17)

3. A ship is propelled by a turbine rotor of mass 500kg and has a speed of 2400 rpm. The rotor has a radius of gyration of 0.5m and rotates in clockwise direction when viewed from stern. Find the gyroscopic effects in the following cases: (i) The ship runs at a speed of 15 knots (1 knot = 1860 m/hr). It steers to the left in a curve of 60m radius (ii) The ship pitches $\pm 5^0$ from the horizontal position with the time period of 20 s of simple harmonic motion (iii) The ship rolls with angular velocity of 0.04 rad/s clockwise during pitching. Determine also the maximum angular acceleration during pitching. Explain how the direction of motion due to gyroscopic effect is determined in each case.**(APR/MAY 17,NOV/DEC 18)**

4. A four motor car of mass 2000kg has a wheel base 2.5m, track width 1.5m and height of center of gravity 50mm above the ground level and lies at 1m from the front axle. Each wheel has an effective diameter of 0.8m and a moment of inertia of $0.8 kgm^2$. The drive shaft, engine flywheel, and transmission are rotating at 4 times the speed of road wheel, in a clockwise direction when viewed from the front, and is equivalent to a mass of 75kg having a radius of gyration of 100mm. If the car is taking right turn of 60m radius at 60 km/hr, find the load on each wheel. **(NOV/DEC 16)**

5. The turbine rotor of a ship has a mass of 3500kg. It has a radius of gyration of 0.45m and a Speed of 300 rpm clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship: (i) When the ship is steering to the left on a curve of 100m radius at a speed of 36kmph (ii) When the ship is pitching in a simple harmonic motion the bow falling with maximum velocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12^0**(NOV/DEC 15)**

6.The driving axle of a locomotive with two wheels has a mass moment of inertia of $350 kgm^2$.The wheels are 1.8min.diameter.The distance between the planes of the wheels is1.5m.When travelling at100km/hr the locomotive passes over a defective rail which causes the righthand wheel to fall 10mm and rise again in a total time of 0.1sec,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 α=0.005m and q=2π/0.1rad/sec.
AUA/M2006,**AUA/M2015**

7.Explain the effect of the gyroscopic couple on the reaction of the four wheels of a vehicle neglecting a curve. **AUN/D2014**

8.The turbine rotor of a ship has a mass of 3500kg. It has a radius of gyration of 0.45m and a speed of 3000r.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 100m 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 is40secondsandthetotalangulardisplacementbetweenthetwo extreme positions of pitching is 12 degrees. **AUM/J2013, AUM/J2014**

GOVERNOR

1. The arms of a porter governor are each 250mm long and pivoted on the governor axis. The mass of the each ball is 5kg and mass of the central sleeve is 30kg.The radius of rotation of the balls is 150mm when the sleeve begins to rise and reaches a value of 200mm for maximum speed. Determine the speed range of the governor. If the friction at the sleeve is equivalent of 20N of load at the sleeve, determine how the speed range is modified. **(APR/MAY 18)**

2. Each arm of a Porter governor is 250mm long. The upper and lower arms are pivoted to links of 40mm and 50mm respectively from the axis of rotation. Each ball has a mass of 5kg and the sleeve mass is 50kg. The force of friction on the sleeve of the mechanism is 40N. Determine the range of speed of the governor for extreme radii of rotation of 125mm and 150mm. **(NOV/DEC 17)**

3. The arms of a Porter governor are 250mm long. The upper arms are pivoted on the axis of revolution, but the lower arms are attached to a sleeve at a distance of 50mm from the axis of rotation. The weight on the sleeve is 600N and the weight of each ball is 80N. Determine the equilibrium speed when the radius of rotation of the balls is 150mm. If the friction is equivalent to a load of 25N at the sleeve, determine the range of speed for this position. **(APR/MAY 17)**

4. A governor of the Proell type has each arm 250mm long. The pivots of the upper and lower arms are 25mm from the axis. The central load acting on the sleeve has a mass of 25kg and the each rotating ball has a mass of 3.2kg. When the governor sleeve is in mid-position, the extension like of the lower arm is vertical and the radius of the path of rotation of the masses is 175mm. The vertical height of the governor is 200mm. If the governor speed is 160 rpm when in mid-position, find the length of the extension link and the tension in the upper arm. **(APR/MAY 17) (CASE STUDY QUESTION)**

5. In a porter governor, each of the four arms is 400mm long. The upper arms are pivoted on the axis of the sleeve, whereas the lower arms are attached to the sleeve at a distance of 45mm from the axis of rotation. Each ball has a mass of 8kg and the load on the sleeve is 60kg. What will the equilibrium speeds for the two extreme radii of 250mm and 30mm of rotation of the governor balls? **(NOV/DEC 16)**

6. Calculate the minimum speed, maximum speed and range of speed of a Porter governor, which has equal arms each 200mm long and pivoted on the axis of rotation. The mass of each ball is 4kg and the central mass on the sleeve is 20kg. The radius of rotation of the ball is 10mm when the governor begins to lift and 130mm when the governor is at maximum speed. **(NOV/DEC 15)**

7.A spring loaded governor of the Hartnell type has equal arms. The balls rotate in a circle of 15cm dia when the sleeve is in the mid position and the ball arms are vertical. The equilibrium speed for this position is 500rpm.The maximum sleeve movement is to be 3cm and the maximum variation of speed taking in account the friction to be of the mid position speed. The mass of the sleeve is5 kg and the friction force may be consideration to arise out of an equivalent to 3kg at the sleeve. The power of the governor must be sufficient to overcome the friction by ±1%change of speed either way at mid-position. Determine1.The rotating mass: 2.the spring stiffness3.the initial compression of spring. Neglect obliquity effect of arms. **AUA/M2015**

8. In an engine governor of the Porter type, the upper and lower arms are 200mm and 250mm respectively and pivoted on the axis of rotation. The mass of the central load is15kg, the mass of each ball is 2kg and friction of the sleeve together with the resistance of the operating gear is equaltoaloadof25Natthesleeve.Ifthelimitinginclinationsoftheupperarmstothevertical are30° and 40°,Find, taking friction into account, range of speed of the governor. **AUN/D2014**

9. The radius of rotation of the balls of a Hartnell governor is 80mm at the minimum speed of 300 r.p.m. Neglecting gravity effect, determine the speed after the sleeve has lifted by 60mm.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=25N/mm. **AUM/J2014**

10.A porter governor has equal arms each 250mm long and pivoted on the axis of rotation. Each ball hasa mass of 5kg and mass of the central load on the sleeve is25kg.The radius of rotation of the ball is150mm when governor be gins 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, (NOV/DEC 18)**

11. 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 is100mm when the governor being to lift and 130mm when the governor is at maximum speed. **AUM/J2009**

12.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 of5 kg 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 AUN/D2010**

13. A Hartnell governor having a central sleeve spring and two right angled bell crank lever operates between 290rpm and 310rpm for a sleeve if to 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 is2.5k

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**

14. 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/J200613.**

15. 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 isochronism's and what would be the speed. Take mass of each ball to be 10kg. (16) **AUN/D2006**

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 ballis10kgand 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 are150mmand 200mm. (16)