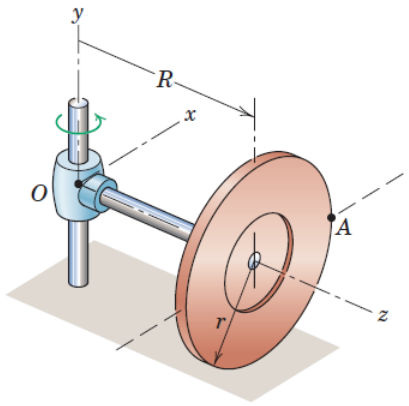
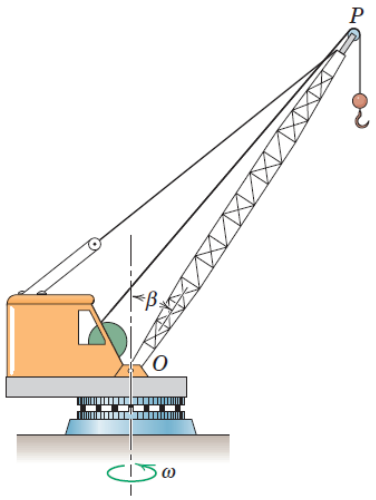
DYNAMICS (ME232)

Tutorial-7: 3-D Dynamics of Rigid Bodies

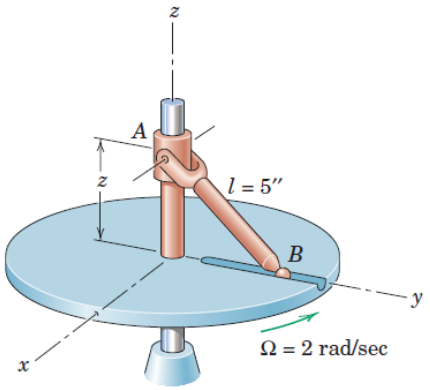
1. The wheel rolls without slipping in a circular arc of radius R and makes one complete turn about the vertical y-axis with constant speed in time τ. Determine expressions for the velocity $\mathbf{v}$ and acceleration $\mathbf{a}$ of point A on the wheel for the position shown, where A crosses the horizontal line through the center of the wheel.



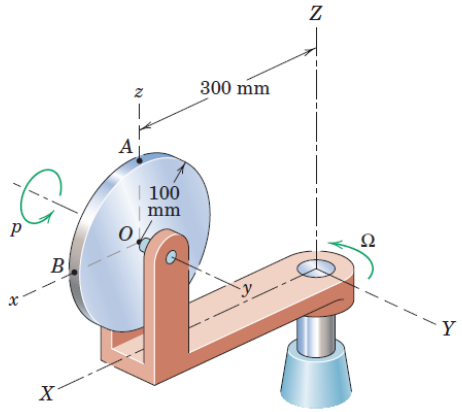
2. The crane has a boom of length $\overline{OP} = 24$ m and is revolving about the vertical axis at the constant rate of 2 rev/min in the direction shown. Simultaneously, the boom is being lowered at the constant rate $\dot{\beta} = 0.10$ rad/s. Calculate the magnitude of the velocity and acceleration of the end P of the boom for the instant when it passes the position $\beta = 30°$.



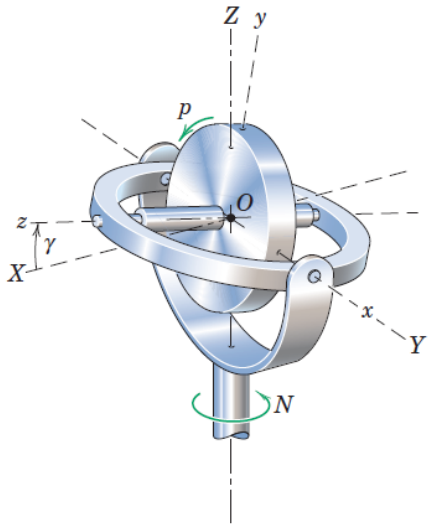
3. The collar and clevis A are given a constant upward velocity of 8 in./sec for an interval of motion and cause the ball end of the bar to slide in the radial slot in the rotating disk. Determine the angular acceleration of the bar when the bar passes the position for $z = 3$ in. The disk turns at the constant rate of 2 rad/sec.



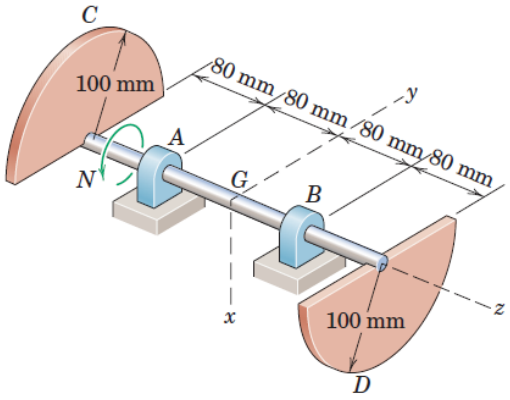
4. The circular disk is spinning about its own axis (y-axis) at the constant rate $P = 10\pi$ rad/s. Simultaneously, the frame is rotating about the Z-axis at the constant rate $\omega = 4\pi$ rad/s. Calculate the angular acceleration $\boldsymbol{\alpha}$ of the disk and the acceleration of point A at the top of the disk. Axes $x - y - z$ are attached to the frame, which has the momentary orientation shown with respect the fixed axes $X - Y - Z$.



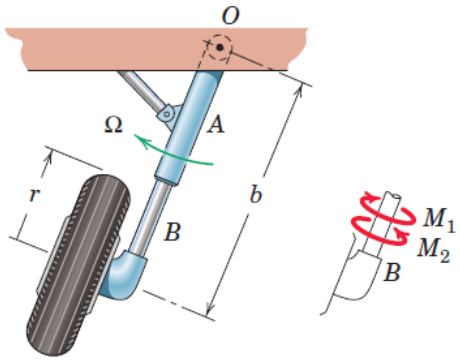
5. The gyro rotor is spinning at the constant rate $p = 100$ rev/min relative to the $x - y - z$ axes in the direction indicated. If the angle γ between the gimbal ring and the horizontal $X - Y$ plane is made to increase at the rate of 4 rad/sec and if the unit is forced to precess about the vertical at the constant rate $N = 20$ rev/min, calculate the angular momentum $\mathbf{H}_0$ of the rotor when $\gamma = 30°$. The axial and transverse moments of inertia are $I_{zz} = 5(10^{-3})$ lb-ft-sec^2 and $I_{xx} = I_{yy} = 2.5(10^{-3})$ lb-ft-sec^2.



6. Each of the two semiconductor disks has a mass of 1.20 kg and is welded to the shaft supported in bearing A and B as shown. Calculate the forces applied to the shaft by the bearing for a constant angular speed $N = 1200$ rev/min. Neglect the forces of static equilibrium.



7. An airplane has just cleared the runway with a takeoff speed v. Each of its freely spinning wheels has a mass m, with a radius of gyration k about its axle. As seen from the front of the airplane, the wheel presesses at the angular rate Ω as the landing strut is folded into the wing about its pivot O. As a result of the gyroscopic action, the supporting member A exerts a torsional moment M on B to prevent the tubular member from rotating in the sleeve at B. Determine M and identify whether it is in the of M_1 or M_2.



8. The blade and hub of the helicopter rotor weigh 140 lb and have a radius of gyration of 10 ft about the z-axis of rotation. With the rotor turning at 500 rev/min during a short interval following vertical liftoff, the helicopter tilts forward at the rate $\dot{\theta} = 10$ deg/sec in order to acquire forward velocity. Determine the gyroscopic moment M transmitted to the body of the helicopter by its rotor and indicate whether the helicopter tends to deflect clockwise or counterclockwise, as viewed by a passenger facing forward.