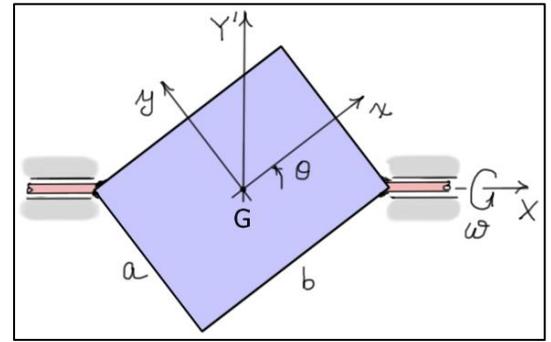
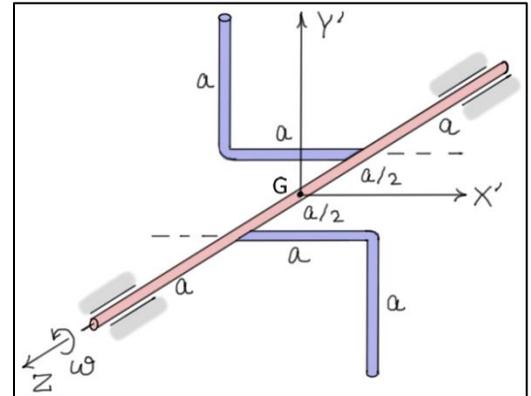


**ME 5550 Intermediate Dynamics**  
**Exercises #7**

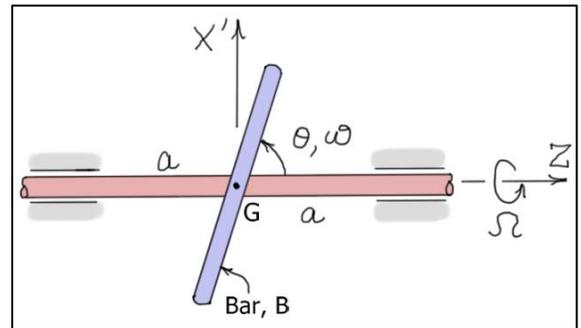
1) A thin rectangular plate  $P$  of mass  $m$  is welded to a shaft, so it rotates about its diagonal as shown. Given that the plate has angular velocity  $\omega$  and angular acceleration  $\alpha$ , find: (a) the bearing loads at the ends of the plate, and (b) the driving torque  $T$ . Assume that the bearing loads are concentrated near the corners of the plate. Express the results in the  $X$ ,  $Y'$ , and  $Z'$  shaft-fixed directions.



2) The system shown consists of two L-shaped arms welded to a shaft of length  $3a$ . Each length  $a$  has mass  $m$ . The planes of the arms are at right angles to the shaft. Given the system has angular velocity  $\omega$  and angular acceleration  $\alpha$ , find: (a) the bearing loads at the ends of the shaft, and (b) the driving torque  $T$ . Assume all parts are made of “slender” bars. Express the results in the  $X'$ ,  $Y'$ , and  $Z$  shaft-fixed directions.



3) The system shown consists of a bar  $B$  of length  $\ell$  and mass  $m$  that is pinned through the center of a shaft of length  $2a$ . As the shaft rotates about the  $Z$ -axis at a constant rate  $\Omega$  (rad/sec),  $B$  rotates about the  $Y$ -axis at a rate  $\dot{\theta} = \omega$  (rad/sec). (a) Find the moments that are transmitted (in the  $X'$  and  $Z$  directions) through the pin at  $G$ . (b) Find the differential equation of motion governing the angle  $\theta$ .



4) The system shown consists of a bar  $B$  of length  $\ell$  and mass  $m$  that is pinned to the bottom of a disk  $D$ . As the disk rotates at a **constant rate**  $\Omega$  (r/s) about the  $Z$ -axis, the bar rotates at a **non-constant rate**  $\dot{\theta}$  (r/s) about the  $X'$ -axis. When the system is at rest, the bar hangs downward under the action of gravity. (a) Find the **bar-fixed** force and moment components transmitted through the pin at  $P$ . (b) Find the differential equation of motion governing the angle  $\theta$ .

