Flipping Physics Lecture Notes:

Rotational Form of Newton's Second Law - Introduction

First we need to review Newton's Second Law of Motion: $\sum \vec{F} = m\vec{a}$

- Force and acceleration are both vectors.
- Includes not just force but the ***net*** force, meaning the addition of all the forces acting on an object.
- When you use this equation you have to identify:
    - what object(s) you are summing the forces on.
    - the direction in which you are summing the forces.

This is the rotational form of Newton's Second Law of Motion: $\boxed{\sum \vec{\tau} = I\vec{\alpha}}$

- Note the similarities between the original second law and the rotational form.
    - Torque is the rotational form of force.
    - Moment of Inertia or Rotational Inertia is the rotational form of inertial mass.
    - Angular acceleration is the rotational form of linear acceleration.
- Torque and angular acceleration are both vectors.
- Includes not just torque but the ***net*** torque, meaning the addition of all the torques acting on an object.
- When you use this equation you have to identify:
    - what object(s) you are summing the torques on.
    - the axis of rotation.
    - the positive torque direction.

Remember: Torque is the ability of a force to cause an angular acceleration of an object. Notice how the rotational form of Newton's Second Law of Motion shows exactly that. A net torque causes an angular acceleration. If you increase the net torque acting on an object without adjusting the moment of inertia or rotational inertia of the object, the angular acceleration of the object with increase.

If you want to hear the equation in words, you can say the angular acceleration of an object produced by a net torque is directly proportional to the magnitude of the net torque, in the same direction as the net torque, and inversely proportional to the moment of inertia or rotational inertia of the object.

$$\sum \vec{F} = m\vec{a} \Rightarrow \vec{a} = \frac{\sum \vec{F}}{m} \ \& \ \sum \vec{\tau} = I\vec{\alpha} \Rightarrow \vec{\alpha} = \frac{\sum \vec{\tau}}{I}$$