Experiment # (5) Rotational Dynamics

Moment of inertia

- **Rotational motion is motion around an axis where every point in the body moves in a circle around the axis of rotation.**
- The operator for this motion called torque.
- The tendency of a body to resist angular acceleration called *moment of inertia*
- its a quantity that determines the torque needed for a desired angular acceleration about a rotational axis.
- First step to study moment of inertia determine the axis of rotation.
- Moment of inertia is a property of a rigid body not of its rotational motion.
- $$I = \sum mr^2$$

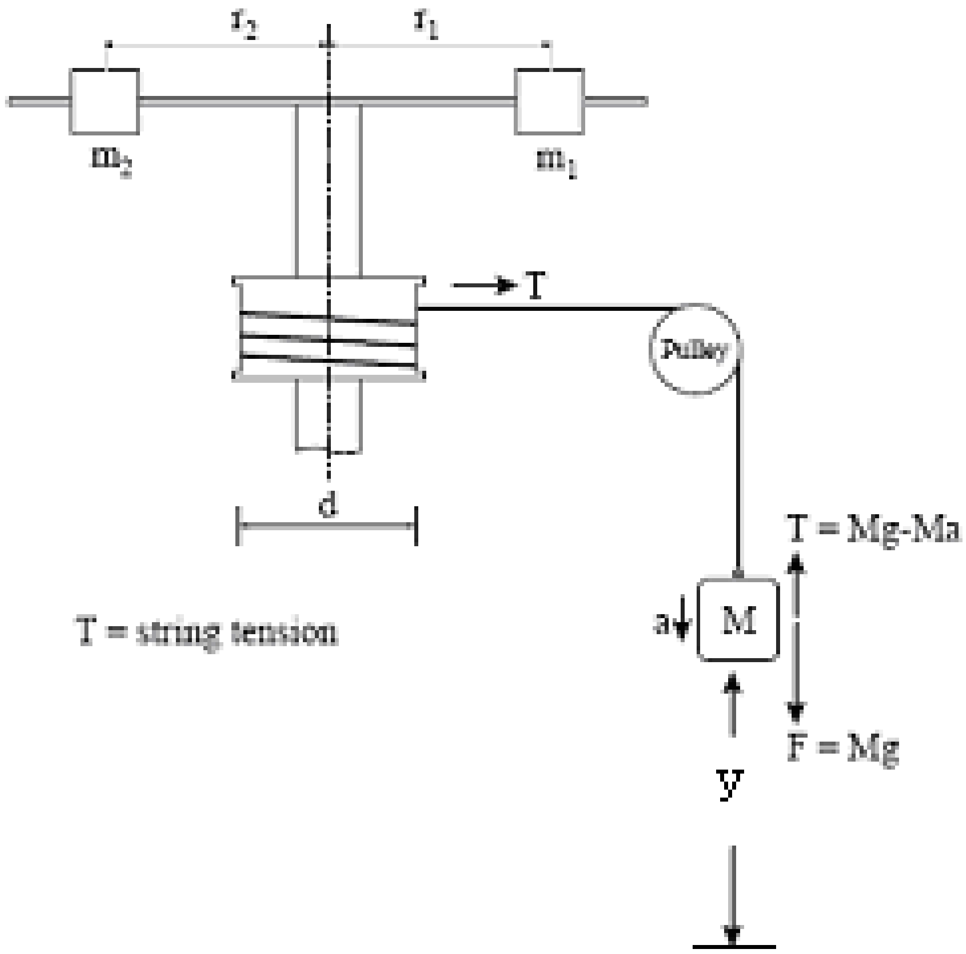
$\vec{\tau} = \vec{r} \times \vec{F}$, $\tau = I\,\alpha$

$$\Rightarrow I = \frac{\tau}{\alpha} = \frac{(Mg - Ma)\frac{d}{2}}{\frac{a}{d/2}}, \quad a = \frac{2y}{t^2}$$

where τ is the torque, r is the lever arm, and F is the force
I is the moment of inertia, α is the angular acceleration.

$$I = \frac{Mgd^2t^2}{8y} - \frac{Md^2}{4}$$ but $\frac{Md^2}{4}$ is very small neglect it.

$$\therefore I_{meas} = \frac{Mgd^2t^2}{8y}$$



d: the diameter of the cylinder.
y: the height of M above the ground.
t: the time needed by M to reach ground.

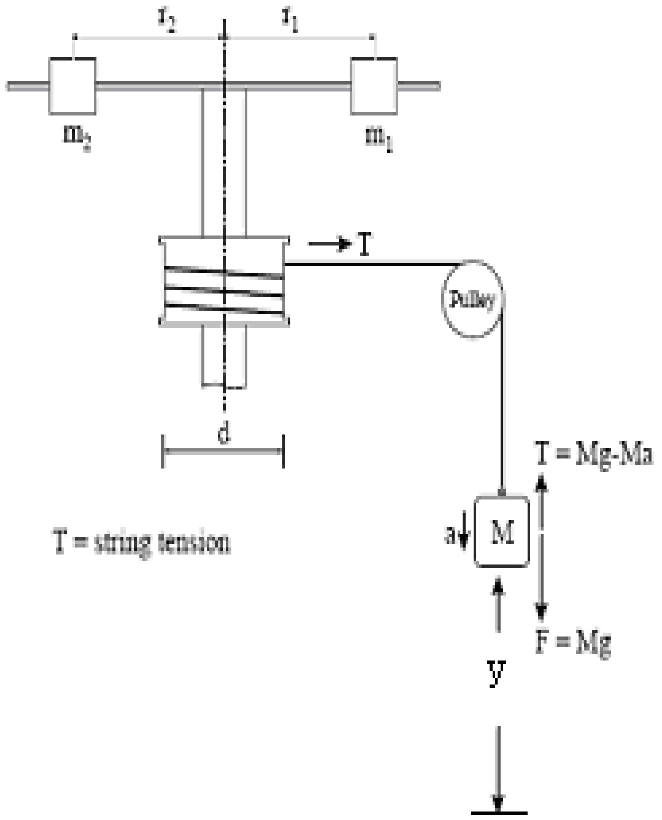
According to parallel axis theorem:

$$I_{sys} = I_{rod,c.m} + I_{cyl,c.m} + m_1 r_1^{\,2} + m_2 r_2^{\,2}$$

$$now\, Let : r_1 = r_2 = r \; and \; m_1 = m_2 = m$$

$$and \; I_{cyl,c.m} \to 0$$

$$\therefore I_{sys} = I_{rod} + 2mr^2$$



r	r^2	t_1	t_2	t_3	t_{avg}	t^2	I_{meas}