

## 37.6: Lees' Rule

Lees' rule, like Routh's rule, is a formula for computing the moment of inertia of a symmetrical solid. It is really a kind of mnemonic device for helping to recall several moment of inertia formulæ.

Lees' rule states that the moment of inertia  $I$  of a body of mass  $M$  about an axis is given by

$$I = M \left( \frac{a^2}{3+n} + \frac{b^2}{3+n'} \right) \quad (37.6.1)$$

where  $a$  and  $b$  are the lengths of the semi-axes perpendicular to the rotation axis, and  $n$  and  $n'$  are the "numbers of principal curvature" that terminate semi-axes  $a$  and  $b$ , respectively ( $n, n' = 0$  for a flat surface, 1 for a cylindrical surface, or 2 for a spherical surface).

### ✓ Example 37.6.1

For example, suppose we want the moment of inertia of a rectangular plate of dimensions  $\ell \times w$ , about an axis through the center of the plate and perpendicular to the plane of the plate.

#### Solution

Then  $a = \ell/2$ ,  $b = w/2$ , and  $n = n' = 0$  because the surfaces are flat. Then Lees' rule gives

$$I = M \left( \frac{\ell^2/4}{3} + \frac{w^2/4}{3} \right) = \frac{1}{12} M (\ell^2 + w^2) \quad (37.6.2)$$

### ✓ Example 37.6.2

As another example, consider the moment of inertia of a solid cylinder of radius  $R$  rotated about its axis.

#### Solution

In this case  $a = b = R$ , and  $n = n' = 1$ . Lees' rule in this case gives

$$I = M \left( \frac{R^2}{4} + \frac{R^2}{4} \right) = \frac{1}{2} MR^2 \quad (37.6.3)$$

### ✓ Example 37.6.3

As a third example, consider the moment of inertia of a solid cylinder of radius  $R$  and length  $\ell$  rotated about an axis perpendicular to the cylinder axis, and passing through the center of the cylinder.

#### Solution

In this case,  $a = R$ ,  $b = \ell/2$ ,  $n = 1$ , and  $n' = 0$ . Then Lees' rule gives

$$I = M \left( \frac{R^2}{4} + \frac{\ell^2/4}{3} \right) = M \left( \frac{R^2}{4} + \frac{\ell^2}{12} \right) \quad (37.6.4)$$

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