## 3) Basic Engineering Information

The following engineering information will help solve technical problems frequently encountered in designing and selecting power transmission components and systems.

### Torque:

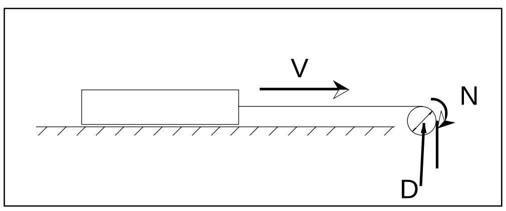
$$T = FR \qquad (1)$$

where:
- $T$ = Torque (lb·ft)
- $F$ = Force (lb)
- $R$ = Radius, or distance that the force is from the pivotal point (ft)

### Linear to rotary motion:

$$N = \frac{V}{0.262D} \qquad (2)$$

where:
- $N$ = Speed of shaft rotation (rpm)
- $V$ = Velocity of material (fpm)
- $D$ = Diameter of pulley or sprocket (in)




### Horsepower:

- Rotating objects:

$$P = \frac{TN}{5250} \qquad (3)$$

where:
- $P$ = Power (hp)
- $T$ = Torque (lb·ft)
- $N$ = Shaft speed (rpm)

- Objects in linear motion:

$$P = \frac{FV}{33000} \qquad (4)$$

where:
- $P$ = Power (hp)
- $F$ = Force (lb)
- $V$ = Velocity (fpm)

### Accelerating torque and force:

- Of rotating objects:

$$T = \frac{(WK^2)\,\Delta N}{308t} \qquad (5)$$

where:
- $T$ = Torque required (lb·ft)
- $WK^2$ = Total inertia of load to be accelerated (lb·ft²) See formulas 7, 8, 9 and 10
- $\Delta N$ = Change in speed (rpm)
- $t$ = Time to accelerate load (sec)

- Objects in linear motion:

$$F = \frac{W\,\Delta V}{1933t} \qquad (6)$$

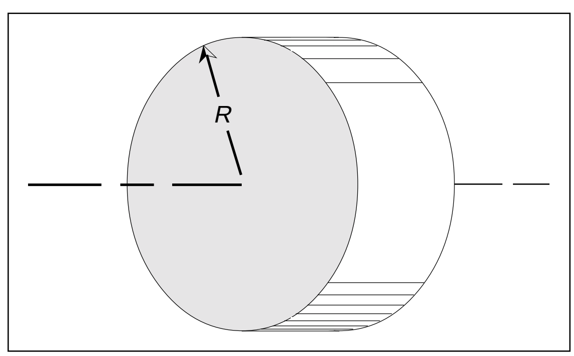
where:
- $F$ = Force required (lb)
- $W$ = Weight (lb)
- $\Delta N$ = Change in velocity (fpm)
- $t$ = Time to accelerate load (sec)

### Moment of Inertia

- Solid cylinder rotating about its own axis

$$WK^2 = \frac{1}{2}WR^2 \qquad (7)$$

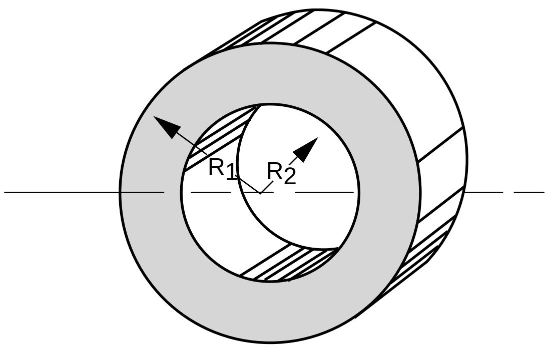
where:
- $WK^2$ = Moment of inertia (lb·ft²)
- $W$ = Weight of object (lb)
- $R$ = Radius of cylinder (ft)



- Hollow cylinder rotating about its own axis:

$$WK^2 = \frac{1}{2} W(R_1^2 + R_2^2) \quad (8)$$

where:
$WK^2$ = Moment of inertia (lb·ft$^2$)
$W$ = Weight of object (lb)
$R_1$ = Outside radius (ft)
$R_2$ = Inside radius (ft)




- Material in linear motion with a continuous fixed relation to a rotational speed, such as a conveyor system:

$$WK_L^2 = W\left(\frac{V}{2\pi N}\right)^2 \quad (9)$$

where:
$WK_L^2$ = Linear inertia (lb·ft$^2$)
$W$ = Weight of material (lb)
$V$ = Linear velocity (fpm)
$N$ = Rotational speed of shaft (rpm)

- Reflected inertia of a load through a speed reduction means — gear, chain, or belt system:

$$WK_R^2 = \frac{WK_L^2}{R_r^2} \quad (10)$$

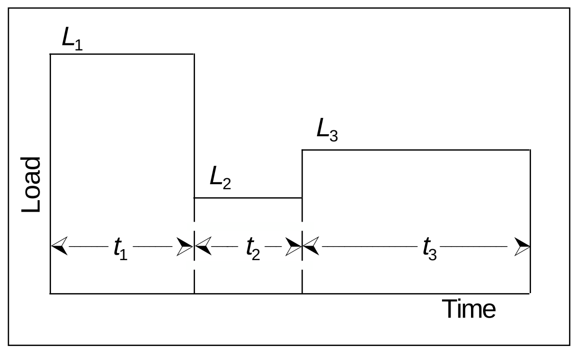
where:
$WK_R^2$ = Reflected inertia (lb·ft$^2$)
$WK_L^2$ = Load inertia (lb·ft$^2$)
$R_r$ = Reduction ratio

## Duty cycle calculation

The RMS (root mean squared) value of a load is one of the quantities often used to size PT components.

$$L_{RMS} = \sqrt{\frac{L_1^2 t_1 + L_2^2 t_2 + \ldots + L_n^2 t_n}{t_1 + t_2 + \ldots t_n}} \quad (11)$$

where:
$L_{RMS}$ = RMS value of the load which can be in any unit — hp, amp, etc.
$L_1$ = Load during time period 1
$L_2$ = Load during time period 2, etc.
$t_1$ = Duration of time period 1
$t_2$ = Duration of time period 2, etc.




## Modulus of elasticity

$$E = \frac{PL}{A\Delta d} \quad (12)$$

where:
$E$ = Modulus of elasticity (lb/in$^2$)
$P$ = Axial load (lb)
$L$ = Length of object (in)
$A$ = Area of object (in$^2$)
$\Delta d$ = Increase in length resulting from axial load (in)