

21-R-KM-SS-31

For a design project, you want to design a DC motor powered hoist to lift payload at a velocity of 0.2m/s using a 2cm diameter pulley. What is the power in lifting a 20 kg payload? If a gear ratio of 15:1 is used (stepping up torque), how much torque does the motor have to provide? What is the shaft power of the motor if the gears have no frictional losses?

Soluton

$$\begin{aligned}\text{Power} &= \text{Load} \cdot \text{Velocity} \\ &= 20g \cdot 0.2 \\ &= 39.24 \quad [\text{ W }]\end{aligned}$$

$$\tau_{\text{out}} = F \cdot r = 1.962 \quad [\text{ Nm }]$$

$$\begin{aligned}\text{Gear ratio} &= \frac{15}{1} = \frac{\tau_{\text{out}}}{\tau_{\text{in}}} \\ \Rightarrow \tau_{\text{in}} &= 0.1308 \quad [\text{ Nm }]\end{aligned}$$

Gears transmit power perfectly if there is no friction.

$$\begin{aligned}P_{\text{shaft}} &= \tau_{\text{motor}} \cdot \omega_{\text{motor}} \\ &= 0.1308 \cdot \left(15 \cdot \frac{0.2}{0.01} \right) \\ &= 39.24 \quad [\text{ W }]\end{aligned}$$