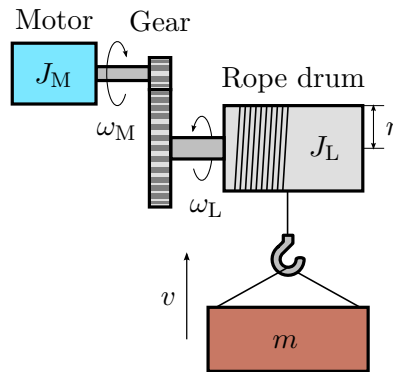


Problem 1: Gears

Consider a hoist drive shown in the figure. The motor is coupled to the rope drum through a gear mechanism, whose gear ratio is $i = \omega_M/\omega_L = 9.6$. The load mass is $m = 500$ kg, the motor inertia is $J_M = 0.5$ kgm², and the rope drum inertia is $J_L = 48.5$ kgm². The radius of the rope drum is $r = 0.25$ m. The rope mass, gear inertias, and the mechanical losses are omitted. Calculate the equivalent total inertia at the motor side and the equivalent load torque at the motor side.

**Problem 2: Electromagnetic torque vs. shaft torque**

A torque sensor is connected between the motor shaft and the load shaft. The load torque is constant $T_L = 150$ Nm and the load inertia is $J_L = 1.0$ kgm². The motor inertia is $J_M = 0.6$ kgm². The speed is increased from zero to $\omega_M = 100$ rad/s in 0.5 s with a constant angular acceleration.

- What is the electromagnetic torque during acceleration? What about the measured torque?
- What is the electromagnetic torque at constant speed? What about the measured torque?

Problem 3: Torque and power

In periodic duty, the mechanical angular speed ω_M and load torque T_L vary as shown in the figure. The total equivalent inertia is 0.04 kgm^2 . The cycle duration is $t_c = 8 \text{ s}$.

- Draw the conceptual waveforms of the electromagnetic torque T_M and mechanical power p_M for one cycle.
- Calculate the rms value of the electromagnetic torque.
- A permanent-magnet DC motor is applied in this periodic duty. The rated torque and rated armature current of the motor are $T_N = 14.3 \text{ Nm}$ and $I_N = 33 \text{ A}$, respectively. What is the maximum armature current during the period?

