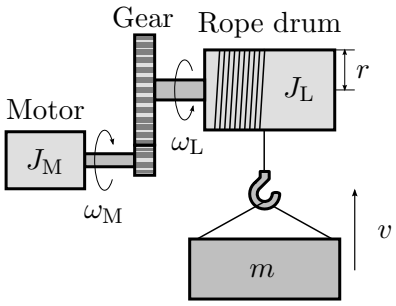
Problem 1: Gears

Consider a hoist drive shown in the figure. The motor is coupled to the rope drum through a gear mechanism, whose gear ratio is $i = \omega_\mathrm{M}/\omega_\mathrm{L} = 9.6$. The load mass is $m = 500$ kg, the motor inertia is $J_\mathrm{M} = 0.5$ kgm^2, and the rope drum inertia is $J_\mathrm{L} = 48.5$ kgm^2. 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 $\tau_\mathrm{L} = 150$ Nm and the load inertia is $J_\mathrm{L} = 1.0$ kgm^2. The motor inertia is $J_\mathrm{M} = 0.6$ kgm^2. The speed is increased from zero to $\omega_\mathrm{M} = 100$ rad/s in 0.5 s with a constant angular acceleration.

(a) What is the electromagnetic torque during acceleration? What about the measured torque?

(b) 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 τ_L vary as shown in the figure. The total equivalent inertia is 0.04 kgm^2. The cycle duration is $T = 8$ s.

(a) Draw the conceptual waveforms of the electromagnetic torque τ_M and mechanical power p_M for one cycle.

(b) Calculate the rms value of the electromagnetic torque.

(c) A permanent-magnet DC motor is applied in this periodic duty. The rated torque and rated armature current of the motor are $\tau_\mathrm{N} = 14.3$ Nm and $i_\mathrm{N} = 33$ A, respectively. What is the maximum armature current during the period?