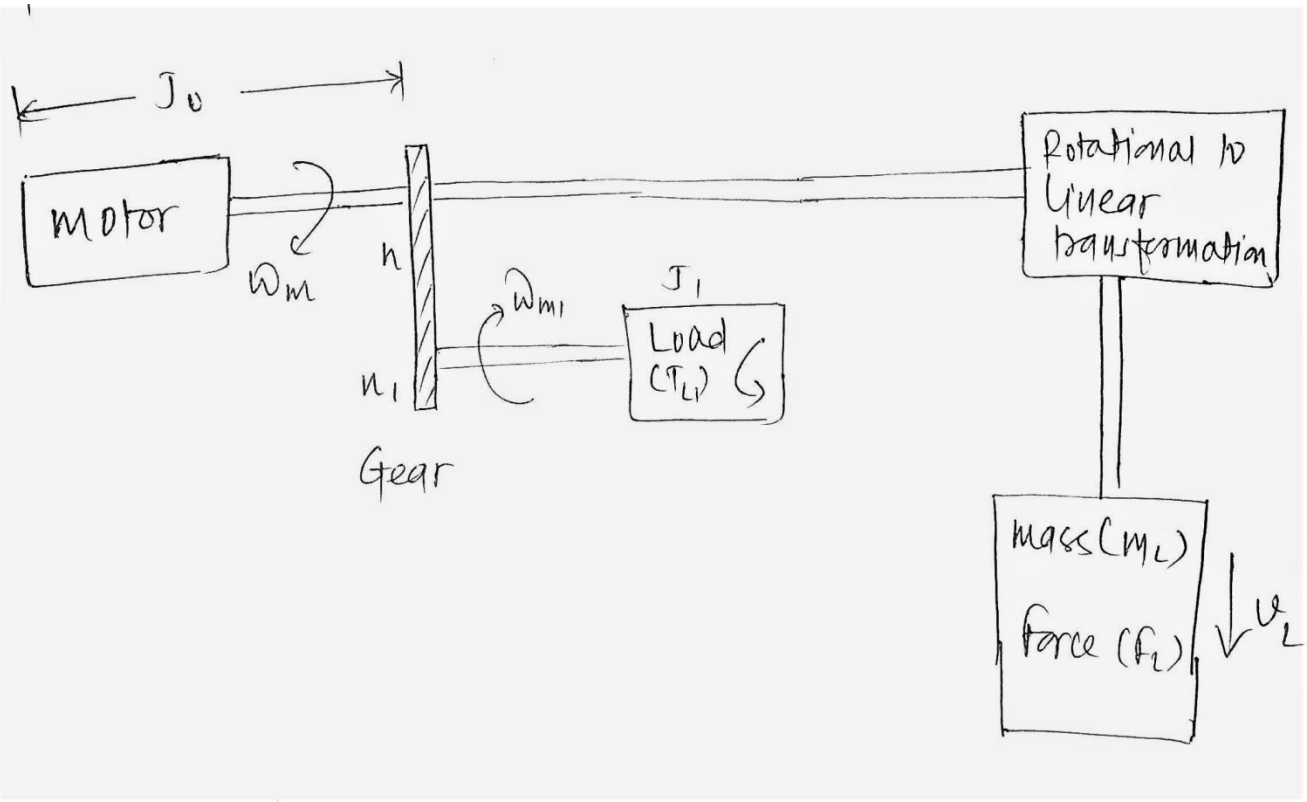
2014 Fall

A motor drives two loads. One has rotational motion and it is coupled to the motor via reduction gear with a=0.1 and efficiency 90%. The load has moment of inertia 10kg-m^2 and torque of 10N-m. Other load has translational motion and consist of 100 kg weight to be lifted up and uniform speed of 1.5 m/sec. The coupling between the motor and load has efficiency of 85%. The moment of inertia of motor is 0.2kg-m^2 and runs at constant speed of 1420 rpm. Determine equivalent inertia referred to motor shaft and power developed by motor.



Sol^{n}:-

Given,

for rotational motion

gear tooth ratio (a_1) = 0.1

transmission efficiency of gearing mechanism (η_1) = 90% = 0.9

moment of inertia of load (J_1) = 10 kg-m^2

Load torque (T_{L1}) = 100 N-m

for translational motion

mass (M_2) = 100 kg

velocity (v_2) = 1.5 m/sec

transmission efficiency (rotational to linear) (η_2) = 85% = 0.85

For motor

moment of inertia of motor (J) = 0.2 kg-m^2

speed of motor (N) = 1420 rpm

Now,

angular speed of motor (ω_m) $= \frac{\pi N}{30} = \frac{1420 \times \pi}{30}$

$= 148.7$ rad/sec

Total moment of inertia referred to motor shaft is

$$J = J_0 + a_1^2 J_1 + M_1 \left(\frac{v_1}{\omega_m}\right)^2$$

$$= 0.2 + (0.1)^2 \times 10 + 1000 \left(\frac{1.5}{148.7}\right)^2 = 0.4 \text{ kg-m}^2$$

And,

Equivalent torque referred to motor shaft is,

$$T_L = \frac{a_1 T_{L1}}{\eta_1} + \frac{f_2 v_2}{\eta_2 \cdot \omega_m} = \frac{0.1 \times 10}{0.9} + \frac{M_2 \times g \times 1.5}{0.85 \times 148.7}$$

$$= \frac{0.1 \times 10}{0.9} + \frac{100 \times 9.8 \times 1.5}{0.85 \times 148.7}$$

$$= 117.3 \text{ N-m}$$