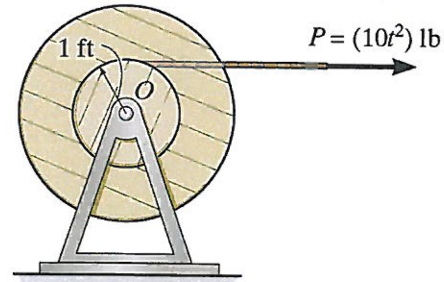
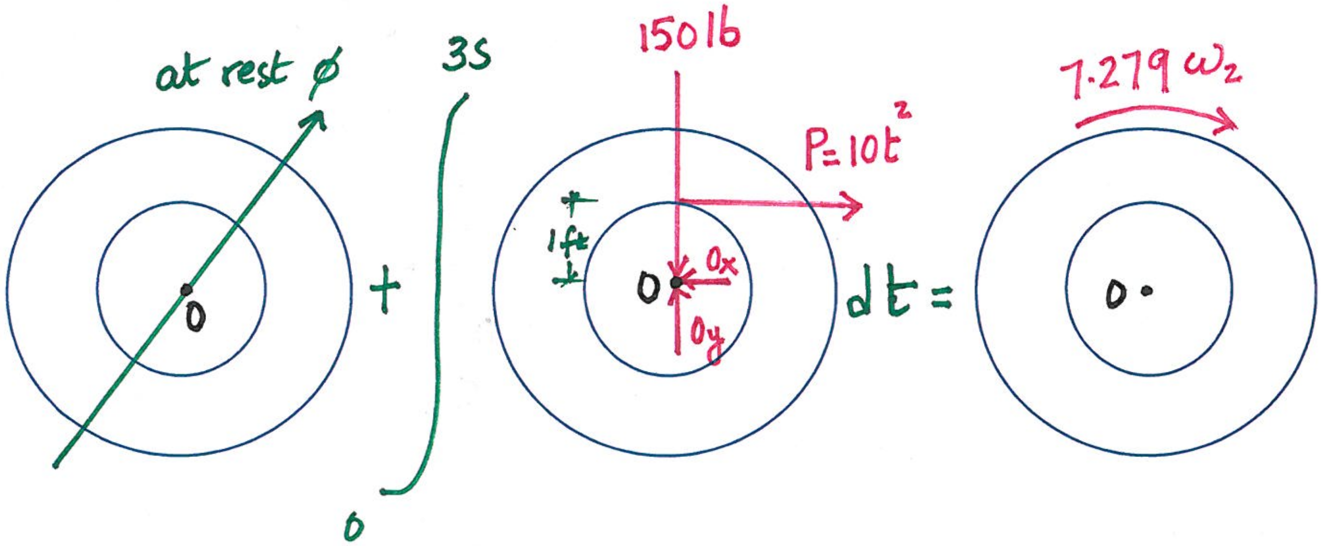
19-4

The cable is subjected to a force of $P = (10t^2)$ lb, where t is in seconds. Determine the angular velocity of the spool 3 s after **P** is applied, starting from rest. The spool has a weight of 150 lb and a radius of gyration of 1.25 ft about its center of gravity.



$$I_o = m k_o^2$$
$$= \left(\frac{150}{32.2}\right)(1.25)^2$$
$$= 7.279 \text{ slug}\cdot\text{ft}^2$$

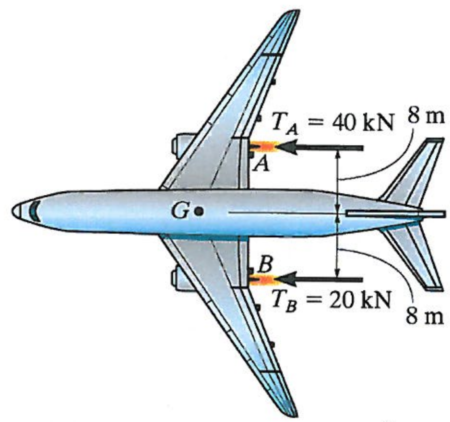
$$\circlearrowright_O : \quad 0 + \int_0^{3s} (10t^2)(1ft)\, dt = 7.279\, \omega_2$$
$$\left.\frac{10t^3}{3}\right|_0^{3s} = 7.279\, \omega_2$$
$$90 = 7.279\, \omega_2 \Rightarrow \underline{\underline{\omega_2 = 12.36 \text{ rad/s} \circlearrowright}}$$



19-7

The airplane is traveling in a straight line with a speed of 300 km/h, when the engines A and B produce a thrust of $T_A = 40$ kN and $T_B = 20$ kN, respectively. Determine the angular velocity of the airplane in $t = 5$ s. The plane has a mass of 200 Mg, its center of mass is located at G, and its radius of gyration about G is $k_G = 15$ m.

$$I_G = m k_G^2$$
$$= (200 \times 10^3 \text{ kg})(15 \text{ m})^2$$
$$= 45 \times 10^6 \text{ kg} \cdot \text{m}^2$$



$$\circlearrowright G: \quad 0 + \int_0^{5s} \left[(40\text{ kN})(8\text{ m}) - (20\text{ kN})(8\text{ m}) \right] dt = (45 \times 10^6 \text{ kg} \cdot \text{m}^2)\,\omega_2$$

$$160t \Big|_0^{5s} = 45 \times 10^6 \,\omega_2$$

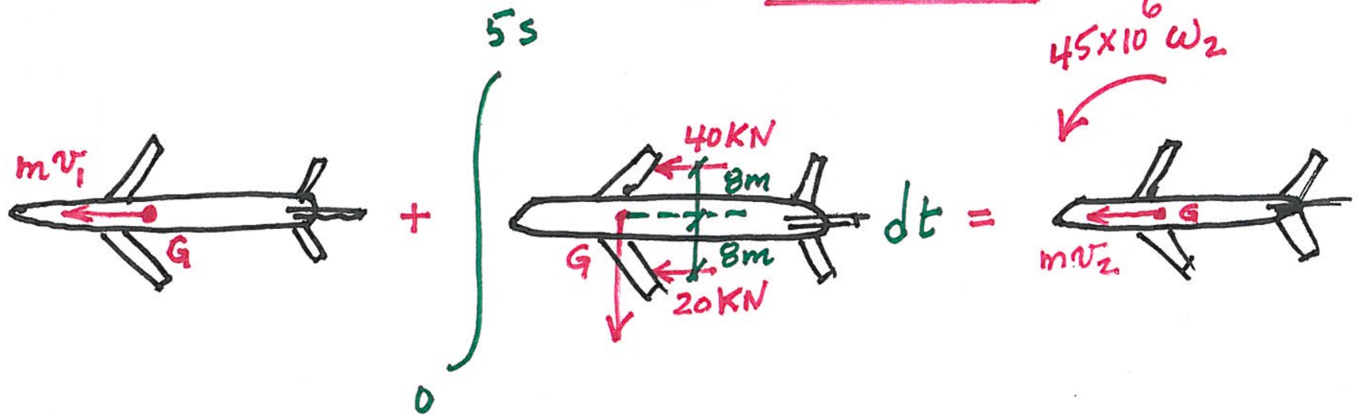
$$800 \text{ kN} \cdot \cancel{\text{m}} \cdot \text{s} = (45 \times 10^6 \text{ kg} \cdot \text{m}^{\cancel{2}})\,\omega_2$$

Note:

$1\text{N} = 1 \text{ kg}\frac{\text{m}}{\text{s}^2}$

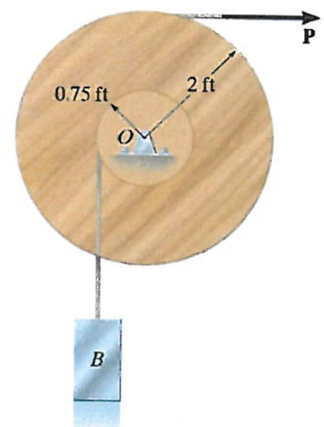
$$800 \times 10^3 \frac{\text{N}}{\text{s}} = 45 \times 10^6 \underbrace{\left(\text{kg}\frac{\text{m}}{\text{s}^2}\right)}_{= \text{N}} \omega_2$$

$$\therefore \omega_2 = \underline{\underline{0.01778 \text{ rad/s} \circlearrowleft}}$$



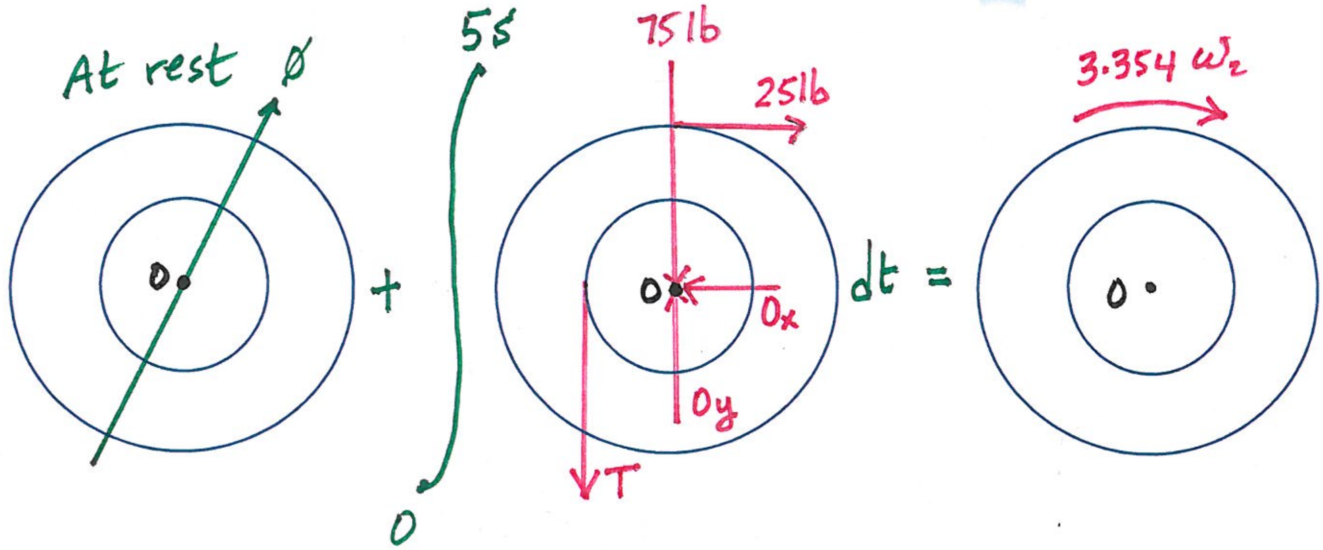
19-12

The spool has a weight of 75 lb and a radius of gyration $k_O = 1.20$ ft. If the block B weighs 60 lb, and a force $P = 25$ lb is applied to the cord, determine the speed of the block in 5 s starting from rest. Neglect the mass of the cord.



$$I_o = m_o k_o^2 = \left(\frac{75}{32.2}\right)(1.20)^2 = 3.354 \text{ slug}\cdot\text{ft}^2$$

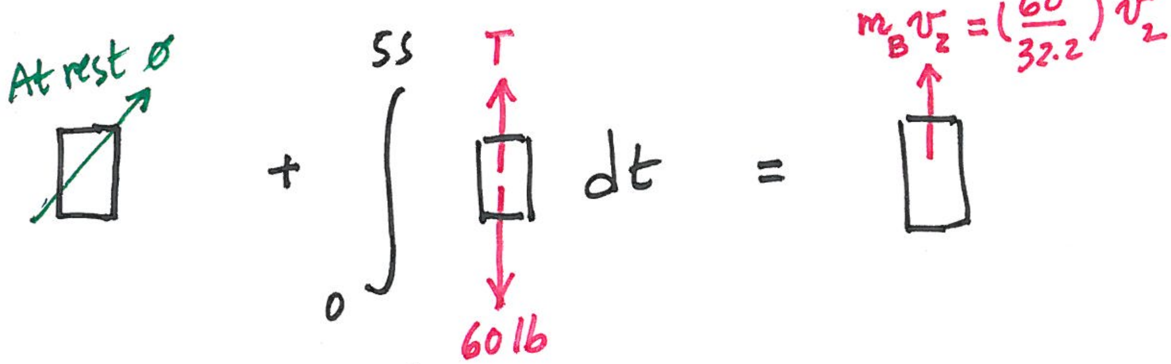
SPOOL:



$$\circlearrowright_O: \quad 0 + \int_0^{5s} \left[(25\text{ lb})(2\text{ ft}) - T\,(0.75\text{ ft})\right] dt = 3.354\,\omega_2$$

$$250 \text{ lb ft s} - 0.75 \int_0^{5s} T\,dt = 3.354\,\omega_2 \quad \text{---- (1)}$$

Block :



$$+\uparrow y: \quad 0 + \int_0^{5s} (T - 60)\, dt = \left(\frac{60}{32.2}\right) v_2$$

↑ speed of block

$$-300 + \int_0^{5s} T\, dt = \left(\frac{60}{32.2}\right) v_2 \quad \text{---}(2)$$

but $v_2 = \omega_2 r = 0.75\, \omega_2$

$$\Rightarrow \omega_2 = 1.33\dot{3}\, v_2 \quad \text{---}(3)$$

Eq (3) in Eq (1)

$$250 - 0.75 \int_0^{5s} T\, dt = 3.354 \times 1.33\dot{3}\, v_2 \quad \text{---}(4)$$

Rewriting Eq (2) & (4)

$$\begin{bmatrix} +0.75 & +4.472 \\ 1 & -1.86335 \end{bmatrix} \begin{Bmatrix} \int_0^{5s} T\, dt \\ v_2 \end{Bmatrix} = \begin{Bmatrix} +250 \\ +300 \end{Bmatrix}$$

$$\underline{\underline{v_2 = 4.26 \text{ ft/s} \uparrow}}$$

↳ speed of the block