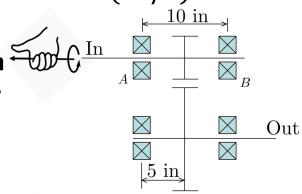
Ex 4)

- **Determine all the loads applied to input shaft and its bearings. The gears are spur gears with $\phi = 20^o$, pitch diameters $d_P = 3.333\ (10/3)$ in, $d_G = 11.667\ (35/3)$ in. The pinion rotates at 1,800 rpm, driven by an electric motor delivering 10 hp.**



Spur gear loads: $\phi = 20^\circ$, $d_p = \frac{10}{3}$ in., $d_G = \frac{35}{3}$ in.

$n_{in} = 1800$ rpm

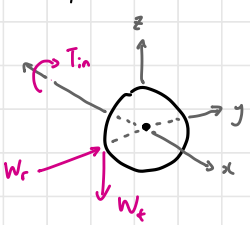
$P_{in} = 10$ hp

$$T_{in} = \frac{P_{in}}{n_{in}} = \frac{d_p}{2} \cdot W_t$$

(torque arm; input force)

$$\therefore\ W_t = \frac{2P_{in}}{n_{in}\, d_p}$$

Pinion pitch circle



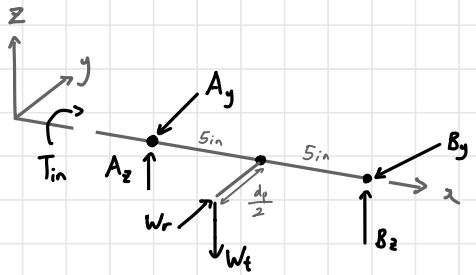
$$n_{in} = 1800 \text{ rpm} \times \frac{2\pi}{60} = 188.5 \text{ rad/s}$$

$$P_{in} = 10 \text{ hp} \times \frac{550 \text{ lb ft/s}}{\text{hp}} = 5500 \text{ lb·ft/s}$$

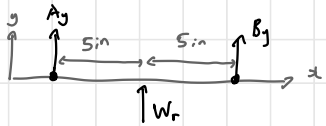
$$W_t = \frac{2P_{in}}{n_{in}\, d_p} = \frac{2 \times 5500 \text{ lb·ft/s}}{188.5 \text{ rad/s} \times \left(\frac{10}{3} \text{ in} \times \frac{1 \text{ ft}}{12 \text{ in}}\right)} = 210.1 \text{ lb}$$

$$W_r = W_t \tan\phi = 210.1 \times \tan 20^\circ = 76.5 \text{ lb}$$

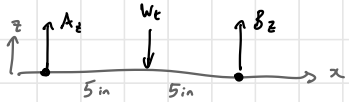
Free-body diagram



x-y plane



x-z plane



$$\sum F_y = A_y + B_y + W_r = 0 \quad (1)$$
$$\sum M_A = 5W_n + 10B_y = 0 \quad (2)$$
$$\sum F_z = A_z + B_z - W_t = 0 \quad (3)$$
$$\sum M_A = -5 \cdot W_t + 10B_z = 0 \quad (4)$$

Solve (1), (2), (3), (4) $\Rightarrow$

$$\begin{cases} A_y = B_y = -38.2 \text{ lb} \\ A_z = B_z = 105.1 \text{ lb} \end{cases}$$

A_y and B_y act in -y direction as expected.

Bearing reaction forces

$$A_r = \sqrt{A_y^2 + A_z^2} = 111.8 \text{ lb}$$
$$B_r = \sqrt{B_y^2 + B_z^2} = 111.8 \text{ lb}$$

} → radial component of the bearing reaction force

$$A_a = 0$$
$$B_a = 0$$

} → axial component of bearing reaction force