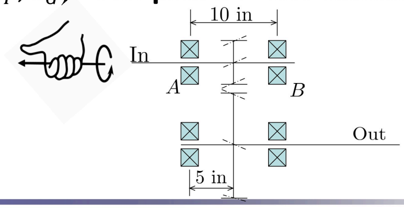
Ex 5)

- **For Ex 4), use helical gears instead of spur gears. Use $\psi = 30^o, \phi_n = 14.5^O$. Other values are the same (input power/speed, P, d_P, d_G). The pinion is left-handed.**



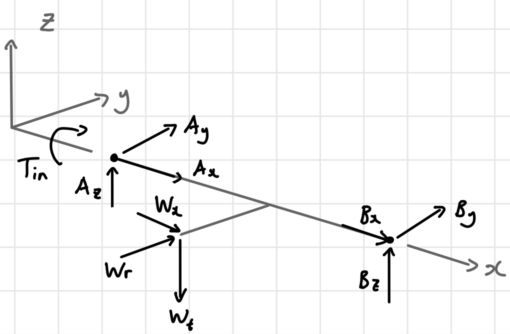
$$\phi_n = 14.5^\circ$$
$$\psi = 30^\circ$$

$$P_{in} = 10 \text{ hp}$$
$$n_{in} = 1800 \text{ rpm}$$
$$d_p = 10/3 \text{ in}$$

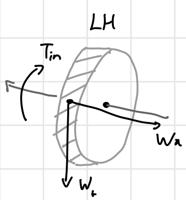
$$\phi_t = \tan^{-1}\left(\frac{\tan\phi_n}{\cos\psi}\right) = 16.63^\circ$$

$$W_r = W_t \tan\phi_t = 210.1 \times \tan 16.63 = 62.75 \text{ lb}$$
$$W_x = W_t \tan\psi = 210.1 \times \tan 30 = 121.3 \text{ lb}$$

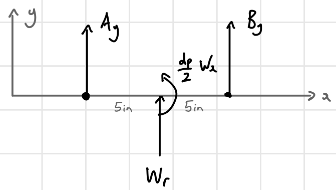
Bearings now need to support W_x. Lets assume the axial load is equally distributed over bearings A and B. (It may not actually be — depends on types of bearings).



The axial force on pinion, W_x, makes the loads on A different from those on B.



① x-y plane (bending)



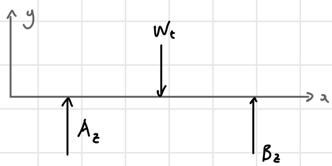
$$\Sigma F_y = W_r + A_y + B_y = 0$$

$$\Sigma M_p = \frac{d_p}{2} W_x - 5A_y + 5B_y = 0$$

$$\therefore A_y = \frac{\frac{d_p}{2} W_x - 5W_r}{10} = \frac{1.67 \times 1.21.3 - 5 \times 54.34}{10}$$

$$= -6.9 \text{ lb}$$

② x-z plane



$$A_z = B_z = \frac{W_t}{2} = 105.2 \text{ lb}$$

Forces on bearing A :

$$F_{rA} = \sqrt{A_y^2 + A_z^2} = 105.3 \text{ lb}$$

$$F_{aA} = |A_x| = \frac{W_x}{2} = \frac{121.3}{2} = 60.65 \text{ lb}$$

Forces on bearing B :

$$F_{rB} = \sqrt{B_y^2 + B_z^2} = 115.31 \text{ lb}$$

$$F_{aB} = |B_x| = \frac{W_x}{2} = \frac{121.3}{2} = 60.65 \text{ lb}$$

The loads on shaft can be analyzed by the beam bending + the torsion.