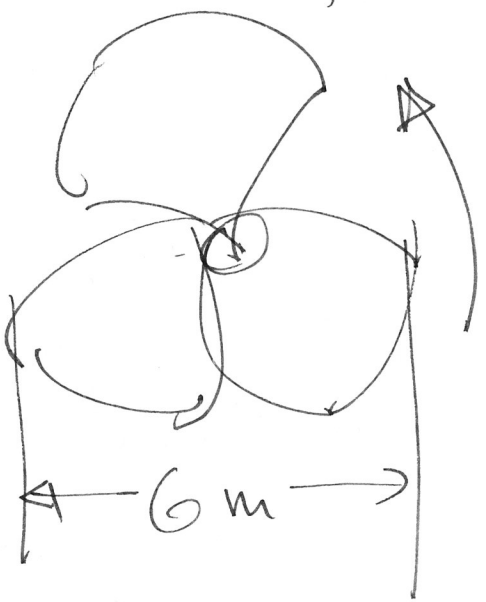
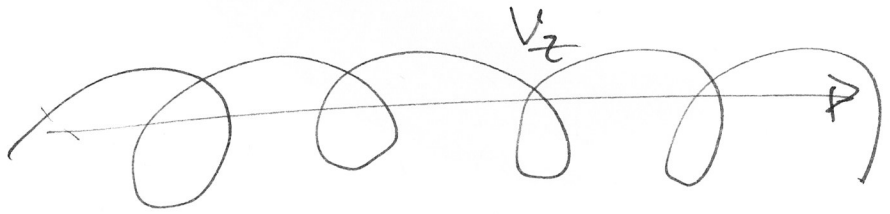
Bruce Emerson Sample Prob (Cylindrical) ENGR 212 1/2

Given:




⊗ $v_z = 11$ m/s = cnst (Assump)




Reqd v & a for point on edge of propeller. magnitude and components.

Strategy r = cnst ⇒ cylindrical. write full expression and identify terms

Estimate: 170 rpm ≅ 3 rev/s  r = 3m ⇒ circ = 2πr = 18m

18 m/1/3 s ≅ 55 m/s = edge velocity ⇒ |V| is a little bigger than 55 m/s - the 11 m/s doesn't count for much. No $a_z$ ⇒ only centripetal ≅ $\frac{v^2}{r} \cong \frac{2500}{3}$

⇒ $a_c$ roughly 800 m/s² = 80 g's!

Solution: $\bar{v} = r\omega e_\theta + \frac{dz}{dt} e_z$ $\quad \frac{dz}{dt} = 11\ m/s$

$\omega$: $170\ rpm = \frac{170\ rev}{60\ s} = 2.83\ rev/s \Rightarrow 2.83(2\pi)\ rad/s = \omega = 17.8\ \frac{rad}{s}$

$$\Rightarrow \bar{v} = 3m\left(17.8\ \tfrac{rad}{s}\right)\hat{e}_\theta + 11\ m/s\,\hat{e}_z = \boxed{53.4\ m/s\,\hat{e}_\theta + 11\ m/s\,\hat{e}_z}$$

$$|v| = \sqrt{53.4^2 + 11^2} = \boxed{54.5\ m/s} = |\bar{v}|$$
(2852, 121)

$$\bar{a} = -r\omega^2 \hat{e}_r + r\alpha \hat{e}_\theta + \frac{d^2z}{dt^2}\hat{e}_z \qquad \frac{d^2z}{dt^2} = 0,\ \alpha = 0$$

$$\Rightarrow \bar{a} = -r\omega^2 \hat{e}_r = -3m\left(17.8\ \tfrac{rad}{s}\right)^2 \hat{e}_r = \boxed{951\ \tfrac{m}{s^2}\,\hat{e}_r = \bar{a}}$$

$$\boxed{|\bar{a}| = 951\ m/s^2}$$

Discussion: All lines up pretty good. Impressive edge acceleration of nearly 100 g's and a speed of nearly 60 m/s (100 mph) - would not want to get hit by that.