P426 Readings
Week 03

1.

ω is the angular frequency in rigid-body motion, so

$$\omega = \frac{d\theta}{dt}$$

2.

Vorticity equation

$$\frac{D\boldsymbol{\omega}}{Dt} = (\boldsymbol{\omega} \cdot \boldsymbol{\nabla})\, \boldsymbol{u} + \nu \nabla^2 \boldsymbol{\omega}^2$$

After given assumptions,

$$\frac{D\boldsymbol{\omega}}{Dt} = \left(\omega \frac{\partial}{\partial z}\right) w = \omega \frac{\partial w}{\partial z}$$

where $\boldsymbol{u} = (0, 0, w)$.

This shows that the angular acceleration depends on the vertical velocity gradient.

3.

In a rigid-body vortex, as well as an irrotational vortex, rotational velocity depends on radius, but the radial component of that velocity is zero. So, a contour over some fluid elements will have constant circulation in time, as material will not change rotational velocity.