Solution to Problem 137A:

The surface of the cylinder in the z-plane is given by $z = Re^{i\theta}$ where $0 \leq \theta \leq 2\pi$, θ being an angle. In the ζ-plane this maps to

$$\zeta \;=\; Re^{i\theta} - Re^{-i\theta} \;=\; 2Ri\sin\theta \;=\; \xi + i\eta \tag{1}$$

Consequently the surface is at $\xi = 0$ (flat plate) and $\eta = 2R\sin\theta$ so the plate extends to $\eta = \pm 2R$. Therefore the plate width is $4R$.

The velocity components, u and v, in the ζ-plane are given by

$$\frac{df}{d\zeta} \;=\; u - iv \;=\; \frac{df}{dz}\left[\frac{d\zeta}{dz}\right]^{-1} \;=\; U\left[1 - \frac{R^2}{z^2}\right]\left[1 + \frac{R^2}{z^2}\right]^{-1} \tag{2}$$

and on the plate surface

$$(u - iv)_{On\ z=Re^{i\theta}} \;=\; iU\tan\theta \tag{3}$$

Therefore on the surface of the flat plate

$$u \;=\; 0 \quad \text{and} \quad v \;=\; -U\tan\theta \tag{4}$$

Hence $|u^2 + v^2| = U^2$ when $\tan\theta = 1$ or $\theta = \pm\pi/4$, that is to say at the points $\eta = \pm\sqrt{2}R$.