Solution to Problem 120I:

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, 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 surface $z = Re^{i\theta}$:

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

So on the surface of the flat plate $u = 0$ and $v = -U\tan\theta$ and $|u^2 + v^2|^{1/2} = U$ when $\tan\theta = 1$ or $\theta = \pm\pi/4$. That is to say at the points $\eta = \pm\sqrt{2}R$.