

Q  
2 In free space  $\vec{B} = \frac{3}{\rho} \cos(\phi) \vec{e}_z$  [Wb/m<sup>2</sup>]. Determine the magnetic flux crossing the strip  $z=0$ ,  $1 < \rho < 3$  [m] and  $0 < \phi < \pi/4$ .

A

$$\begin{aligned} \oint \vec{B} \cdot d\vec{s} &= \int \left( \frac{3}{\rho} \cos \phi \vec{e}_z \right) \cdot (\rho d\rho d\phi \vec{e}_z) \\ &= \int_{\rho=1}^3 \int_{\phi=0}^{\pi/4} 3 \cos \phi d\rho d\phi = 3 \left( \sin \phi \Big|_{\phi=0}^{\pi/4} \right) \left( \rho \Big|_{\rho=1}^3 \right) \\ &= 6 \sin(\pi/4) \\ &= 4.24 \text{ [Wb]} \end{aligned}$$