$\boxed{6}$ Same as problem 5 halfway. P and Q are crossings of m and a curved surface of the cylinder. As same as problem 5,

$$PQ = \frac{2}{\sqrt{3}}|2\sin\theta - 1| \qquad \cdots ①$$

Next, let π be a tangent plane to the cylinder at a line PQ

$$\pi : \cos\theta y + \sin\theta z = 1 \qquad \cdots ②$$

Let h to be a distance between π and $A(0, 0, 2)$,then

$$h = \frac{|2\sin\theta - 1|}{\sqrt{\cos^2\theta + \sin^2\theta}} = |2\sin\theta - 1| \qquad \cdots ③$$

Define plane $\pi(\theta)$ as a plane which includes a line $m(\theta)$ and point $A(0, 0, 2)$. In addition,define the volume of the cone enclosed by $\pi(\theta)$, $\pi(\theta + \Delta)$ and the curved surface of the cylinder as ΔV ,then if $\Delta\theta \fallingdotseq 0$

$$\Delta V \fallingdotseq \frac{1}{3} \times (PQ \times 1 \cdot \Delta\theta) \times h = \frac{2}{3\sqrt{3}}(2\sin\theta - 1)^2\Delta\theta \qquad \cdots ④$$

Therfore the volume of the cone above the cylinder is

$$\begin{aligned} V &= \frac{2}{3\sqrt{3}} \int_{\frac{\pi}{6}}^{\frac{5\pi}{6}} (2\sin\theta - 1)^2 d\theta \\ &= \frac{4\sqrt{3}}{9}\pi - 2 \qquad \cdots ans. \end{aligned}$$