2. $f(x,y) = e^{2x} - \cos y$, $P(0,\pi)$ $\vec{v} = 2\vec{i} + 4\vec{j}$

① $\vec{u} = \dfrac{\vec{v}}{\|\vec{v}\|} = \dfrac{2\vec{i}+4\vec{j}}{\sqrt{2^2+4^2}} = \dfrac{2\vec{i}+4\vec{j}}{\sqrt{4+16}} = \dfrac{2\vec{i}+4\vec{j}}{\sqrt{20}} = \dfrac{2\vec{i}+4\vec{j}}{2\sqrt{5}}$

$= \dfrac{2}{2\sqrt{5}}\vec{i} + \dfrac{4}{2\sqrt{5}}\vec{j}$

$= \dfrac{1}{\sqrt{5}}\vec{i} + \dfrac{2}{\sqrt{5}}\vec{j}$

$\vec{u} = \dfrac{\sqrt{5}}{5}\vec{i} + \dfrac{2\sqrt{5}}{5}\vec{j}$

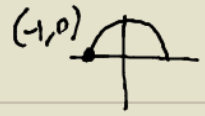
② $\nabla f(x,y) = f_x\vec{i} + f_y\vec{j}$

$= e^{2x}\cdot 2\vec{i} + (-(-\sin y))\vec{j}$

$= 2e^{2x}\vec{i} + \sin y\,\vec{j}$

③ $\nabla f(\underset{x}{0},\underset{y}{\pi}) = 2e^{2\cdot 0}\vec{i} + \sin\pi\,\vec{j}$

$= 2\vec{i}$



④ $D_u f(0,\pi) = \nabla f(0,\pi)\cdot\vec{u}$

$= (2\vec{i})\cdot\left(\dfrac{\sqrt{5}}{5}\vec{i} + \dfrac{2\sqrt{5}}{5}\vec{j}\right)$

$= \boxed{\dfrac{2\sqrt{5}}{5}}$