② $r(u,v) = (\sin(4u)\cos(v))i + (\sin(4u)\cdot\sin v)j + (8u)k$

$$\iint_D f(r(u,v)) \underbrace{\left|\frac{dr}{du} \times \frac{dr}{dv}\right| du\,dv}_{ds}$$

• $\dfrac{dr}{du} = [4\cos v\cdot\cos 4u,\ 4\sin v\cdot\cos 4u,\ 8]$

• $\dfrac{dr}{dv} = [-\sin 4u\cdot\sin v,\ \sin 4u\cdot\cos v,\ 0]$

$$\frac{dr}{du} \times \frac{dr}{dv} = \begin{vmatrix} i & j & k \\ 4\cos v\cdot\cos 4u & 4\sin v\cdot\cos 4u & 8 \\ -\sin 4u\cdot\sin v & \sin 4u\cdot\cos v & 0 \end{vmatrix}$$

$= i(-8\sin 4u\cdot\cos v) - j(8\sin 4u\cdot\sin v)$

$+ k(2\sin 8u)$

$= [-8\sin 4u\cdot\cos v,\ -8\sin 4u\cdot\sin v,\ 2\sin 8u]$

$= \left|\dfrac{dr}{du} \times \dfrac{dr}{dv}\right| = \sqrt{(-8\sin 4u\cdot\cos v)^2 + (-8\sin 4u\cdot\sin v)^2 + (2\sin 8u)^2}$

$$= \left| \frac{dr}{du} \times \frac{dr}{dv} \right| = \underline{2\sqrt{\sin^2 8u + 16\sin^2 4u}}$$

$$= \int_0^{\frac{\pi}{2\cdot 4}} \int_0^{\pi} 2\sqrt{\sin^2 8u + 16\sin^2 4u} \cdot \sqrt{8^2 + 4^2\cos^2 4u}\, dv\, du$$

$$= \underline{\underline{\frac{52}{3}\pi}}$$