⑤ $C(r,\theta) = (r\cos\theta, r\sin\theta, 16-r^2)$, $r \in [0,4]$, $\theta \in [0,2\pi]$

$$C_r = \begin{pmatrix} \cos\theta \\ \sin\theta \\ -2r \end{pmatrix}, \quad C_\theta = \begin{pmatrix} -r\sin\theta \\ r\cos\theta \\ 0 \end{pmatrix} \Rightarrow C_r \times C_\theta = \begin{pmatrix} 2r^2\cos\theta \\ 2r^2\sin\theta \\ r \end{pmatrix}$$

$$\|C_r \times C_\theta\| = \sqrt{4r^4\cos^2\theta + 4r^4\sin^2\theta + r^2} = r\sqrt{4r^2+1}$$

$$\text{Surface Area} = \int_\Sigma dS = \int_0^{2\pi}\int_0^4 r\sqrt{4r^2+1}\,dr\,d\theta \qquad \begin{pmatrix} u = 4r^2+1 \\ du = 8r\,dr \end{pmatrix}$$

$$= \frac{1}{8}\int_0^{2\pi}\int_1^{65} u^{1/2}\,du\,d\theta = \frac{1}{12}\int_0^{2\pi} u^{3/2}\Big|_1^{65}\,d\theta = \frac{1}{12}\int_0^{2\pi}(65^{3/2}-1)\,d\theta$$

$$= \boxed{\frac{\pi}{6}(65^{3/2}-1)}$$

⑥ (a) $\int_C F \cdot ds = f(1,1) - f(0,0)$

$= (e+1) - (1+0)$

$= \boxed{e}$

(b) $\int_C F \cdot ds = f(\gamma(\pi)) - f(\gamma(0))$

$= f(0,-1) - f(0,1)$

$= (1+0) - (1+0)$

$= \boxed{0}$

⑦ When $z=4$, the z-component of F is 0. This is the only component of F that will contribute to the flux over a horizontal disk, because the normal vector to a horizontal surface is vertical. Thus, the flux is $\boxed{0}$.

⑧ $$\int_0^{2\pi}\int_0^{\pi}\int_0^{2} \rho^2 \cdot \rho^2 \sin\phi\,d\rho\,d\phi\,d\theta = \int_0^{2\pi}\int_0^{\pi} \frac{\rho^5}{5}\sin\phi\Big|_0^2\,d\phi\,d\theta$$

$$= \int_0^{2\pi}\int_0^{\pi} \frac{32}{5}\sin\phi\,d\phi\,d\theta = \int_0^{2\pi} -\frac{32}{5}\cos\phi\Big|_0^{\pi}\,d\theta = \int_0^{2\pi}\left(\frac{32}{5}+\frac{32}{5}\right)d\theta$$

$$= 2\pi \cdot \frac{64}{5} = \boxed{\frac{128\pi}{5}}$$