Optional bonus: bonus 15 points for the final exam

(1) Please complete the following TWO questions by **typing up the solution and providing us with the figure about the problem.** Handwritten solution will NOT be graded.
(2) For typing up, students are advised to use LaTeX (you can use it at Overleaf : www.overleaf.com). Students can also use Word File, though it will take longer time.
(3) For Figures, you can use desmos3D, or some other program that you know.
(4) Please declare how you work out the problem. e.g. you work in groups with another students, use Woform Alpha or even you use ChatGPT or other AI, you have to declare. Failure of the declaration may result in 0 points.
(5) Please submit a PDF file on Canvas by next Friday.

Questions. 1. Let $\mathbf{F}(x, y, z) = \sin(x^2)\mathbf{i} + xz\mathbf{j} + z^2\mathbf{k}$. Evaluate $\int_C \mathbf{F} \cdot d\mathbf{r}$ around the curve C of the intersection of the cylinder $x^2 + y^2 = 4$ with the surface $z = x^2$ in counter-clockwise direction as viewed from the top on the z-axis. 2. Let E be the solid region between the plane $z = 4$ and the paraboloid $z = x^2 + y^2$. Let

$$\mathbf{F}(x, y, z) = \left(-\frac{1}{3}x^3 + e^{z^2}\right)\mathbf{i} + \left(-\frac{1}{3}y^3 + x\sin z\right)\mathbf{j} + 4z\mathbf{k}.$$

Let S be the surface that encloses E. Find

$$\iint_S \mathbf{F} \cdot d\mathbf{S}.$$