(1) Evaluate the line integral

$$\int_C \boldsymbol{F} \cdot \boldsymbol{dr},$$

where $\boldsymbol{F}(x, y) = (1 + 2xy)\boldsymbol{i} + (1 + x^2)\boldsymbol{j}$ and C is the curve parameterised by

$$\boldsymbol{r}(t) = t\boldsymbol{i} + \sin(\frac{\pi}{2}t^2)\boldsymbol{j}, \quad 0 \leq t \leq 1.$$

(2) Let C be a circle of radius 1 centred at the point $(x, y) = (1, 0)$. Consider the vector field $\boldsymbol{F}(x, y) = x\boldsymbol{i} + x(1 + y)\boldsymbol{j}$. Calculate the two line integrals over C,

$$\oint_C \boldsymbol{F} \cdot \boldsymbol{T}\, ds \text{ and } \oint_C \boldsymbol{F} \cdot \boldsymbol{n}\, ds,$$

where $\boldsymbol{T}$ is the unit tangent vector to C traversed in an anticlockwise direction, and $\boldsymbol{n}$ is a unit normal vector to C directed away from the centre of the circle.

(3) Evaluate the line integral

$$\oint_C \big((y^2 - x)dx + (3x + y)dy\big)$$

where C is the boundary of the region in the x-y plane enclosed by the parabola $y = x^2$ and the line $y = 1$, traversed in an anticlockwise direction.

(4) Find the area of the part of paraboloid $y = x^2 + z^2$ that lies inside the cylinder $x^2 + z^2 = 1$.
