Some answers will involve π, square roots, fractions, etc. Do not round off.

(1) (20 pts.) Let \( A = (1, 2, 1) \) and \( B = (1, 0, 1) \). Show that the integral
\[
\int_{A}^{B} 3z\,dx - 2y\,dy + (2 + 3x)\,dz
\]
is path independent. Evaluate the integral.

(2) (20 pts.) Let \( C \) be the plane curve \( y = 1 - x^3 \), from \((0, 1)\) to \((1, 0)\). Evaluate the line integral
\[
\int_{C} \mathbf{F} \cdot \mathbf{T} \, ds
\]
for the vector field
\[
\mathbf{F} = yi - xj.
\]

(3) (20 pts.) Let \( R \) be the region in the \( xy \)-plane bounded by the \( x \)-axis and the parabola \( y = 1 - x^2 \). Let \( C \) be the boundary of \( R \). For the vector field
\[
\mathbf{F} = (y + x^2)i + (y - x)j,
\]
use Green’s Theorem to evaluate
(a) the counterclockwise circulation of \( \mathbf{F} \) around \( C \), and
(b) the outward flux of \( \mathbf{F} \) across \( C \).

(4) (20 pts.) Let \( C \) be the intersection of the plane \( z = 1 + x - y \) and the cylinder \( x^2 + y^2 = 1 \). Assume \( C \) is oriented in the counterclockwise direction when viewed from above. For the vector field
\[
\mathbf{F} = (z^2 - e^x)i + (x^2 + \tan y)j + (y^2 - z^5)k,
\]
use Stokes’ theorem to calculate the line integral
\[
\oint_{C} \mathbf{F} \cdot \mathbf{T} \, ds
\]
of \( \mathbf{F} \) around \( C \).

(5) (20 pts.) Let \( D \) be the solid region which is bounded on the bottom by the cone \( z = \sqrt{x^2 + y^2} \) and on the top by the plane \( z = 1 \). Let \( S \) be the boundary of \( D \), oriented outward. For the vector field
\[
\mathbf{F} = 2xyi + (6 - y^2)j + (x^2 + y^2 + z^2)k,
\]
use the divergence theorem to calculate the surface integral
\[
\iint_{S} \mathbf{F} \cdot \mathbf{N} \, dS.
\]
That is, find the flux of \( \mathbf{F} \) across \( S \).