(10) I. Calculate the value of \( \int_{0}^{1} \int_{0}^{x+y} \int_{0}^{z} z \, dz \, dy \, dx \).

(10) II. Give a function \( f : \mathbb{R} \to \mathbb{R}^3 \) that is a parametrization of the piece of the surface with equation \( x - xy + z = 10 \) that lies above the region in the xy-plane bounded by \( x = 0, x = 1, y = 0, \) and \( y = x^2 \).
(20) III. If $C$ is the closed curve formed by the unit circle oriented counterclockwise, with parametrization $f(t) = (\cos t, \sin t)$ for $0 \leq t \leq 2\pi$.

A. What is the value of $\int_C u(x, y) \, dL$ if $u(x, y) = \frac{1}{x^2 + y^2}$?

B. What is the value of $\int_C \mathbf{F} \cdot d\mathbf{x}$ if $\mathbf{F}(x, y) = \left( \frac{x}{x^2 + y^2}, \frac{y}{x^2 + y^2} \right)$?
IV. Suppose \( F \) is the vector field given by \( F(x, y, z) = x \mathbf{i} \). If \( C \) is the straight line segment from \((1, 1, 1)\) to \((3, 4, 5)\),

A. Give a parametrization for \( C \).

B. Calculate \( \int_C F \cdot d\mathbf{x} \).
V. \( f : \mathbb{R}^2 \rightarrow \mathbb{R}^3 \) defined by \( f(s, t) = (s, \cos t, \sin t) \) with \( 0 \leq s \leq 4 \) and \( 0 \leq t \leq 2\pi \) is a parametrization of a surface \( M \) in \( \mathbb{R}^3 \).

Calculate the surface integral \( \iint_M (x + z) \, d\sigma \).

VI. Compute the line integral of the vector field \( \mathbf{F} \) over the curve \( C \), where \( \mathbf{F}(x, y) = (y, x^2) \) and \( C \) is the boundary of the right triangle with vertices (0, 0), (0, 2), and (1, 0) oriented counter-clockwise.
(20) VII. Given the vector field \( \mathbf{F}(x, y, z) = (y, x, 0) \),

A) Prove that \( \mathbf{F} \) is path independent \( \mathbb{R}^3 \) by finding a potential function for \( \mathbf{F} \).

B) If \( \mathbf{C} \) is a path in \( \mathbb{R}^3 \) parametrized by \( \mathbf{c}(t) = \left( \frac{t^4}{4}, \sin \left( \frac{t\pi}{2} \right), 0 \right) \) with \( 0 \leq t \leq 1 \) calculate the line integral \( \int_{\mathbf{C}} \mathbf{F} \cdot d\mathbf{x} \).