I. The equations $S = (x^2 + y^2)^2$, $t = x - y$ define a transformation $f: \mathbb{R}^2 \rightarrow \mathbb{R}^2$, such that $f(x, y) = (S, t)$. Let $A = \{ (x, y) : x^2 + y^2 \leq a^2 \, g \}$, where $a > 0$ is given.
Find (a) $f(A)$, (b) $f^{-1}(A)$

II. Find the limit at $X_o$ if it exists.
(a) $f(x, y) = \frac{xy}{x^2 + y^2}$, $X_o = e_1 + e_2$
(b) $f(x, y) = \frac{xy^2}{x^2 + y^2}$, $X_o = (0, 0)$
(c) $f(x, y) = ye_1 + \frac{(xy)^2}{(xy)^2 + (x - y)^2}e_2$, $X_o = (0, 0)$

III. Show that a sequence $[X_m]$ has at most one limit $X_o$.

IV. Let $A$ be a closed, convex, nonempty set, and $X_o \notin A$.
Show that there is exactly one point $X \in A$ nearest $X_o$.

V. Let $f(x, y) = (x-1)^2 - y^2$. Find the derivative of $f$ at $e_2$ in any direction $V$, using the definition of the dir. deriv.

VI. Let $n=3$ and $L(x, y, z) = x + y + 2z$, (a) what is the vector $A = (a_1, a_2, a_3)$ corresponding to $L$? (b) Describe the set $\{ (x, y, z) : L(x, y, z) = c \}$.

VII. Find grad $f(X)$ for (a) $f(X) = X, X$, (b) $f(X) = 1X1$, $X \neq 0$ and (c) $f(X) = (X_0, X)^2$.