Name:_____   **Score:**_____

Instructions: Show your work in the spaces provided below for full credit. Use the reverse side for additional space, *but clearly so indicate.* You must clearly identify answers and show supporting work to receive any credit. Exact answers (e.g., π) are preferred to inexact (e.g., 3.14). Point values of problems are given in parentheses. Notes or text in *any* form not allowed. Calculator is required.

(24) **1.** Let $f(x, y, z) = 3x^2 y - z \cos x$.
(a) Find $\bigtriangledown f(0, 2, -1)$.

(b) Find a unit vector in the direction of the maximum directional derivative of f at the point $(0, 2, -1)$.

(c) Find an equation for the tangent plane to the surface $f(x, y, z) = 1$ at the point $(0, 2, -1)$.

(18) **2.** Given a function $g(u, v) = f(x(u, v), y(u, v))$ with all continuous partials, find $\partial^2 g / \partial u^2$ in terms of f, x, y and their partials.

(33) **3.** Let $f(x,y) = 3x^3 + y^2 - 9x + 4y$.

(a) Find all critical points of f.

(b) Use the second derivative test to classify the critical points of f.

(c) Suppose the domain of $f(x,y)$ is restricted to the square $0 \leq x, y \leq 2$. Does $f(x,y)$ have a global maximum or minimum on this domain? In either case, explain your answer and briefly indicate how you would find them if an answer is affirmative.

(25) **4.** Let $f(x, y) = 4xy$.

(a) Find the extrema of f subject to the constraint $4x^2 + y^2 = 8$ by the method of Lagrange multipliers.

(b) Find the absolute extrema of f over the region $4x^2 + y^2 \le 8$.