Part I. **No** partial credit will be given in this part. Do not need to show all your work. Only the **final result** will be needed.

(1) (7 points) Find the slope of the curve $y^2 = x^2 + \sin(xy)$ at the point $(0, 1)$.

(2) (7 points) The marginal cost of manufacturing x yards of a certain fabric is $C'(x) = 3x^2 - 12x + 15$ (in dollars per yard). Find the increase in cost if the production level is raised from 10 yards to 20 yards.

(3) (7 points) Find $\lim_{x \to 0} \frac{1}{x^3} \int_0^x \frac{t^2}{t^4 + 1} dt$.

(4) (7 points) Find the area of the region bounded by the curve $y = xe^{-x}$ and the x-axis from $x = 0$ to $x = 4$.

(5) (7 points) Find the volume of the solid generated by revolving about the x-axis the region bounded by the curve $y = \frac{4}{(x^2 + 4)}$, the x-axis, and the lines $x = 0$ and $x = 2$.

(6) (7 points) Find the direction in which $f(x, y, z) = x^3 - xy^2 - z$ increases most rapidly at the point $(1, 1, 0)$.

(7) (7 points) Find the local extreme values of the function $f(x, y) = xy - x^2 - y^2 - 2x - 2y + 4$.

(8) (7 points) Find the volume of the tetrahedron D with vertices $(0, 0, 0)$, $(1, 1, 0)$, $(0, 1, 0)$, and $(0, 1, 1)$.

(9) (7 points) Integrate $f(x, y, z) = x - 3y^2 + z$ over the line segment C joining the point $(1, 1, 0)$ to the point $(1, 1, 1)$.

(10) (7 points) Calculate the outward flux of the field $\mathbf{F}(x, y) = x\mathbf{i} + y^2\mathbf{j}$ across the square bounded by the lines $x = -1$, $x = 1$, $y = -1$, and $y = 1$.

(11) (7 points) Find the circulation of the field $\mathbf{F}(x, y, z) = (x^2 - y)\mathbf{i} + 4z\mathbf{j} + x^2\mathbf{k}$ around the curve C in which the plane $z = 2$ meets the cone $z = \sqrt{x^2 + y^2}$, counterclockwise as viewed from above.

Part II. Partial credits will be given in this part. Show **all your work** to get credits.

(12) (8 points) Show that the function $f(x) = x^4 + 2x^2 - 2$ has exactly one zero on the interval $[0, 1]$.

(13) (8 points) Show that $\tan^{-1} x = x - \frac{x^3}{3} + \frac{x^5}{5} - \cdots + (-1)^n \frac{x^{2n+1}}{2n+1} + \cdots$, $-1 \le x \le 1$.

(14) (7 points) Show that the function $f(x, y) = \frac{2x^2 y}{x^4 + y^2}$ has no limit as (x, y) approaches $(0, 0)$