
Instructions:

- No calculators, tablets, phones, or other electronic devices are allowed during this exam.
 - You may use one handwritten sheet of notes (8.5"×11" double-sided), but no books or other aids.
 - Fill in your Name and PID on this page.
 - Read each question carefully and answer each question completely.
 - Write your solutions clearly and legibly.
 - Show all of your work; no credit will be given for unsupported answers.
 - Circle your final answers.
 - Exams must be turned in promptly when time is called.
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0. (1 point) Carefully read and complete the instructions on this exam and any additional instructions announced during the exam.
1. (6 points) Find the global maximum and minimum values of $f(x, y) = 3x^2 + 3y^2 + 12y + 27$ on the region $\mathcal{D} = \{(x, y) | x^2 + y^2 \leq 25\}$.
2. (6 points) The temperature at a point (x, y) centimeters is $T(x, y)$ degrees Celsius, with $\frac{\partial T}{\partial x}(2, 3) = 4$ and $\frac{\partial T}{\partial y}(2, 3) = 10$, both in degrees Celsius per centimeter. A tarantula crawls so that its position after t seconds is given by $x = \frac{1}{2}t^2$ centimeters and $y = 2 + \frac{1}{2}t$ centimeters.
 - (a) How fast is the temperature rising on the tarantula's path when $t = 2$ seconds?
 - (b) In what direction from the point $(2, 3)$ does the temperature *decrease* most rapidly? Express the direction as a unit vector.
3. (6 points) Tom is chasing Jerry up a spiral staircase. The chase starts at time $t = 0$.
The position of Tom at time t is $\mathbf{T}(t) = \langle \cos(4\pi t), \sin(4\pi t), 2t \rangle$
and the position of Jerry is $\mathbf{J}(t) = \langle \cos(2\pi t), \sin(2\pi t), t + 3 \rangle$.
 - (a) At what time does Tom catch Jerry?
 - (b) What is the distance covered by Tom from time $t = 0$ until he catches Jerry?
4. (6 points) Find the two points on the ellipsoid $2x^2 + 3y^2 + 2z^2 - 2xz = 24$ at which the tangent plane is horizontal; that is, parallel to the xy -plane.
5. (6 points) Let $f(x, y) = 2xy + y^2$.
 - (a) Find an equation for the tangent plane to the graph of f at the point $(1, 2, 8)$.
 - (b) Use this to approximate the value of $f(1.02, 2.03)$. Note again, calculators are not allowed. You should compute the specific approximation requested, rather than the exact value of $f(1.02, 2.03)$.