Instructions

1. Write your Name, PID, Section, and Exam Version on the front of your Blue Book.
2. No calculators or other electronic devices are allowed during this exam.
3. You may use one page of notes, but no books or other assistance during this exam.
4. Read each question carefully, and answer each question completely.
5. Write your solutions clearly in your Blue Book.
   (a) Carefully indicate the number and letter of each question and question part.
   (b) Present your answers in the same order as they appear in the exam.
   (c) Start each numbered problem on a new side of a page.
6. Show all of your work. No credit will be given for unsupported answers, even if correct.
7. Write Name & PID on this exam sheet and return inside front cover of your Blue Book.

0. (1 point) Carefully read and complete the instructions at the top of this exam sheet and any additional instructions written on the chalkboard 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 \( D = \{(x, y) \mid x^2 + y^2 \leq 25\} \).

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) The path \( \mathbf{c}(t) = \left(3 \cos (t), 3 \sin (t), 2 \frac{3^2}{2}\right) \) traces out a curve \( \mathcal{C} \).
   (a) Find the length of the curve \( \mathcal{C} \) traced out by \( \mathbf{c}(t) \) for \( 0 \leq t \leq 3 \).
   (b) Give an example of a path \( \mathbf{r}(t) \) in three dimensions that has constant speed but nonzero acceleration. Be sure to show your example has constant speed and nonzero acceleration.

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.

(This exam is worth 25 points.)