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. 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 they appear in the exam.
   (c) Start each problem on a new page.
5. Show all of your work. No credit will be given for unsupported answers (even if correct).
6. Turn in your exam paper with 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) Let $f(x, y) = x^3y + 12x^2 - 8y$.
   (a) Find all critical points of $f$.
   (b) Classify each critical point of $f$ as a local maximum, local minimum, or saddle point.

2. (6 points) Find an equation for the plane passing through the points $(1, 1, 5)$, $(1, -3, 1)$, and $(6, 1, 1)$.

3. (6 points) Let $\vec{v} = \vec{i} + \vec{j} - \vec{k}$ and $\vec{w} = 2\vec{i} - \vec{j} + \vec{k}$.
   (a) Compute $\vec{v} \cdot \vec{w}$.
   (b) Compute $\vec{v} \times \vec{w}$.
   (c) Find the angle between $\vec{v}$ and $\vec{w}$. You may express this angle as the inverse cosine (or arccosine) of a number.

4. (6 points) A rectangular box without a top has a volume of $32 \text{ cm}^3$. Find the dimensions of the box having minimal surface area.

5. (6 points) Find the maximum and minimum values of the function $f(x, y) = xy$ subject to the constraint $9x^2 + y^2 = 18$.  

(Please turn over.)
6. (6 points) Let $f$ be a function that has the contour diagram given below.
   (a) Find the coordinates (to the nearest 0.2) of the local maxima and local minima of the function $f$.
   (b) The function $f$ also has at least one saddle point. Find the coordinates (to the nearest 0.2) of the saddle point(s).

7. (6 points) Evaluate the double integral $\int \int_R (x^2 + xy) \, dA$, where $R$ is the triangle in the $xy$-plane having vertices at $(0, 0)$, $(1, 1)$, and $(1, 0)$.

8. (7 points) Evaluate the integral by reversing the order of integration $\int_0^1 \int_{y^2}^1 4y \sin(x^2) \, dx \, dy$. 

This exam is worth 50 points.