Instructions:
1. Write your *Name, PID, Section Number,* and *Exam Version* on the *front* of your blue book.
2. Draw the following table on the inside cover of your blue book:

0	
1	
2	
3	
4	
5	
6	
7	
8	
$\sum$	

3. You may use one $8.5x11$ in. sheet of *handwritten* notes, but no books or other assistance during this exam.
4. No calculator, phones, or any other electronic devices are allowed during this exam.
5. Present your solutions clearly in your Blue Book:

(a) Carefully indicate the number and letter of each question and each part of a question.
(b) Present your answers in the same order as they appear in the exam.
(c) Start each problem on a new page.

6. Show all of your work. Unsupported answers will receive no credit.
7. Turn in your exam paper and your note sheet with your Blue Book.

0. (1 point.) Carefully read and follow the instructions.

1. Let
$$\overrightarrow{u} = \langle 3, 1, 4 \rangle, \ \overrightarrow{v} = \langle 2, 7, 1 \rangle$$
   (a) Find a vector orthogonal to both $\overrightarrow{u}$ and $\overrightarrow{v}$.
   (b) Find the angle between $\overrightarrow{u}$ and $\overrightarrow{v}$.
   (c) Calculate the projection of $\overrightarrow{u}$ onto $\overrightarrow{v}$.
   (d) Compute the area of the parallelogram spanned by $\overrightarrow{u}$ and $\overrightarrow{v}$.

2. Find the equation of the plane containing the points
$$A = (1, 0, 1),\ B = (2, 1, 0),\ C = (-1, -1, -1).$$

3. Use linear approximation to estimate the value of
$$(1.01)^3\sqrt{.98}$$

4. Find and classify all critical points of the following function as local maxima, local minima or saddle points.
$$f(x, y) = xy + x^2y - xy^2$$

5. A farmer from Omaha, Nebraska is tending to his corn field in the dead of winter. He is wandering about the farm, examining his property. His position at time t is given by
$$x = t\cos(t),\ y = t^2\sin(t)$$
where x and y are his lattitude and longitude respectively. The temperature in degrees Fahrenheit at any point in the field is given by the function
$$T(x, y) = 50e^{-x^2-y^2}.$$
What is the rate of change in the farmer's temperature with respect to time at time $t = \pi$.

6. Calculate the double integral
$$\int_1^2 \int_0^2 xy\sqrt{x^2+1}dydx$$

7. Find the maximum and minimum values of the function
$$f(x, y) = x^2 - y^3$$
when constrained to the ellipse
$$2x^2 + 3y^2 \leq 6.$$

8. Calculate the following double integral:
$$\int_0^2 \int_{\frac{y}{2}}^1 ye^{x^3}dxdy$$