DIRECTIONS

1. There are 10 questions worth a total of 100 points.

2. Questions 1 - 6 are Multiple Choice worth 5 points. Enter your answer in the box provided to the side of the question.

3. Questions 7 - 11 are Free Responses worth 14 points each and are to be answered in the space provided on the test.

4. Read all the questions carefully.

5. For the Free Response, you must show all work in order to receive credit!! When possible, box your answer, which must be complete, organized, and exact unless otherwise directed.

6. Always indicate how a calculator was used (i.e. sketch graph, etc. ...).

7. No calculators with QWERTY keyboards or ones like TI-89 or TI-92 that do symbolic algebra may be used.

Honor Statement: By signing below you confirm that you have neither given nor received any unauthorized assistance on this exam. This includes any use of a graphing calculator beyond those uses specifically authorized by the Mathematics Department and your instructor. Furthermore, you agree not to discuss this exam with anyone until the exam testing period is over. In addition, program memory of your calculator and menus may be checked at any time and cleared by any testing center proctor or Mathematics Department instructor.

Signature: _____________________ Date: ___________________
1. Use the Chain Rule to find the indicated partial derivatives. Calculate 
\[ \frac{\partial u}{\partial x}, \frac{\partial u}{\partial y}, \frac{\partial u}{\partial t} \] when \( x = 1, \ y = 2, \ t = 0 \) for 
\[ u = \sqrt{r^2 + s^2} \]
where 
\[ r = y + x \cdot \cos(t), \ s = x + y \cdot \sin(t). \]
Select the correct answer.

(A) \( \frac{\partial u}{\partial x} = \frac{4}{\sqrt{10}}, \ \frac{\partial u}{\partial y} = \frac{3}{\sqrt{10}}, \ \frac{\partial u}{\partial t} = \frac{2}{\sqrt{10}} \)
(B) \( \frac{\partial u}{\partial x} = 4, \ \frac{\partial u}{\partial y} = 3, \ \frac{\partial u}{\partial t} = 2 \)
(C) \( \frac{\partial u}{\partial x} = \frac{5}{\sqrt{10}}, \ \frac{\partial u}{\partial y} = \frac{3}{10}, \ \frac{\partial u}{\partial t} = \frac{3}{10} \)
(D) \( \frac{\partial u}{\partial x} = \frac{1}{\sqrt{10}}, \ \frac{\partial u}{\partial y} = \frac{3}{\sqrt{10}}, \ \frac{\partial u}{\partial t} = \frac{5}{\sqrt{10}} \)
(E) None of these

2. Let \( f(x, y) = x \cdot \sin(x + y) \), find \( \frac{\partial^2 f}{\partial x \partial y} \)

(A) \( \sin(x + y) + x \cdot \cos(x + y) \)
(B) \( \cos(x + y) - x \cdot \sin(x + y) \)
(C) \( \cos(x + y) + x \cdot \sin(x + y) \)
(D) \(-x \cdot \cos(x + y)\)
(E) None of these

3. Which is the reversing order of integration of 
\[ \int_0^1 \int_x^1 f(x, y)dydx \]
Select the correct answer.

(A) \( \int_0^1 \int_0^1 f(x, y)dxdy \)
(B) \( \int_0^1 \int_0^1 f(x, y)dydx \)
(C) \( \int_0^1 \int_0^x f(x, y)dxdy \)
(D) \( \int_0^1 \int_0^y f(x, y)dxdy \)
(E) None of these
4. Evaluate the integral by converting to polar coordinates

\[ \int_{-1}^{1} \int_{0}^{\sqrt{1-y^2}} \sin(x^2 + y^2) \, dx \, dy \]

(A) \( \pi \cdot \frac{1-\cos(1)}{2} \)
(B) \( \sin(1) \)
(C) \( \pi \cdot \frac{1-\sin(1)}{2} \)
(D) \( 2\pi \cdot \frac{1+\cos(1)}{2} \)
(E) None of these

5. The directional derivative is defined as

\[ \frac{\partial f}{\partial u} = \nabla f \cdot u \]

where \( u = (u_1, u_2) \) is a unit vector, i.e., \( u \cdot u = 1 \). Calculate the directional derivative for

\[ f(x, y) = y \cdot \ln(x) \]

in the direction

\[ u = \left(-\frac{4}{5}, \frac{3}{5}\right) \]

at the point

\[ (x, y) = (1, -3) \]

Select the correct answer.

(A) \( \frac{12}{15} \)

(A) \( -\frac{12}{15} \)

(A) \( \frac{2}{15} \)

(A) \( -\frac{7}{5} \)

(E) None of these

6. The length \( L \), width \( W \), and height \( H \) of a box change with time \( t \), at a certain instant the dimensions are \( L = 20 \text{cm}, W = H = 15 \text{cm} \) and \( L \) and \( W \) are increasing at a rate of \( 3 \text{cm/s} \) while \( H \) is decreasing at a rate of \( 2 \text{cm/s} \). At that instant the rate of change of the volume of the box is

(A) \( 975 \text{cm}^3/\text{s} \).

(B) \( -75 \text{cm}^3/\text{s} \).

(C) \( 4500 \text{cm}^3/\text{s} \).

(D) \( 900 \text{cm}^3/\text{s} \).

(E) None of these
FREE RESPONSE

7. Find all critical points for the given function and classify them as local maxima, minima, saddle, parabolic points or neither.

\[ z = e^{2x+3y} \cdot (8 \cdot x^2 - 6 \cdot xy + 3 \cdot y^2) \]

8. Find an equation of the tangent plane to the graph of the given function at the specified point.

\[ z = y \cdot \cos(x - y), \quad (2, 2, 2) \]

9. Find the volume of the solid below

\[ z = x \cdot y \]

and above the region of \((x, y)\)-plane bounded by \(y = x\) and \(y = x^2\).

10. Evaluate the integral by reversing the order of integration

\[ \int_0^1 \int_0^{\sqrt{3}+1} \sqrt{y^3 + 1} \, dx \, dy \]

11. Evaluate the double integral

\[ \int \int_D x \cdot e^y \, dA \]

where \(D\) is the region of \((x, y)\)-plane defined as

\[ D = \{(x, y); \ 0 \leq x \leq 1, \ 0 \leq y \leq x\} \]