

MARK BOX		
PROBLEM	POINTS	
1	10	
2	10	
3	10	
4	10	
5	10	
6	10	
TOTAL	60	
%	100	

NAME: _____

SSN: _____

INSTRUCTIONS:

- To receive credit you must:
 - work in a logical fashion, show all your work, indicate your reasoning
 - when applicable put your answer on/in the line/box provided
 - if no such line/box is provided, then box your answer
 - if you use your calculator on a particular problem, then indicate so.
- The MARK BOX indicates the problems along with their points. Check that your copy of the exam has all of the problems.
- As indicated on the syllabus:
 - allowed is a calculator (but not a computer)
 - allowed are the class handouts: table of integrals, calculus formula sheet, and Spring 2000 informal summary (along with your personal scribbles on them)
 - not allowed are books and other notes.
- During this exam, do not leave your seat. If you have a question, raise your hand. When you finish: turn your exam over, put your pencil down, and raise your hand.
- This exam covers (from *Vector Calculus* by Marsden&Tromba, 4th ed.): Chs. 1, 2, § 3.1, 4.1, 4.2 .

Problem Inspiration:

- an example from class
 - homework problem ch 1 review # 9 and quiz 2 problem 2
 - homework problem ch 2 review # 7
 - quiz 3 problem 4
 - an example from class , § 2.6 # 21
 - 1997 exam 1 # 5 .
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- 3.** An equation of the plane tangent to the graph of

$$f(x, y) = x^2 + y^4 + e^{xy}$$

at the point $(1, 0, f(1, 0))$ is:

Remark: your solution should be of the form $ax + by + cz = d$.

4. Captain Ralph is out for a flight in his space ship again, traveling at a constant speed of e^6 meters per second. The temperature of the ship's hull when he is at location (x, y, z) will be given by

$$T(x, y, z) = \exp(-x^2 - y^2 - z^2)$$

where $x, y,$ and z are measured in meters. He is currently at $(1, 2, 1)$. Describe the set of possible directions in which he may proceed to bring the ship's hull temperature *down* at exactly a rate of $3\sqrt{2}$ degrees per second. Box your answer.

5. Mount Calc has the shape of the paraboloid

$$z = 1 - x^2 - y^2$$

where x and y are the east-west and north-south map coordinates and z is the altitude above sea level (x, y, z are all measured in kilometers). If a puffo is at the point

$$\left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}} \right)$$

and heads up Mount Calc in the direction of $\langle 11, -13 \rangle$, then he is climbing Mount Calc at approximately a _____ % grade.

Round your answer to a whole number. Recall from an example in class that a 3% grade means that

$$\frac{\text{change in vertical distance traveled}}{\text{change in horizontal distance traveled}} = \frac{3}{100} .$$

6. Houston, we have a problem. The space shuttle Atlantis is traveling along with position vector

$$\vec{\mathbf{r}}(t) = \langle t^2, 3t^2, 4t \rangle .$$

If the power thrusters are turned off at time t , the Atlantis will coast off, with constant speed along a straight path tangent to the vector $\vec{\mathbf{r}}(t)$. The Atlantis is almost out of fuel when astronaut John Grunsfeld notices the Mir space station off ahead of them at the position $(220, 660, 64)$. John realizes that their only hope is to turn the thrusters off, just at the proper time, so that the Atlantis will safely coast to dock with the Mir; but, John is not sure if his plan will work. So John quickly calls Tom and Ray for advice. Tom claims that John's plan will work; Ray claims that John's plan will not work. Who is right: Tom or Ray? Why? BE SURE TO MATHEMATICALLY SUPPORT YOUR ANSWER, EXPLAINING YOUR THOUGHT PROCESS. If so needed, continue on the next (blank) page.

MORE SPACE FOR PROBLEM 6: