Name:

SM223 – Calculus III with Optimization Fall 2017
Assoc. Prof. Nelson Uhan

Exam 2 – 5 October 2017

Instructions

- You have until the end of the class period to complete this exam.
- You may not use a calculator.
- You may not consult any other outside materials (e.g. notes, textbooks, homework).
- **Show all your work.** Your answers should be legible and clearly labeled. It is your responsibility to make sure that I understand what you are doing. You will be awarded partial credit if your work merits it.
- Keep this booklet intact.
- **Do not discuss the contents of this exam with any midshipmen until it is returned to you.**

Problem	Weight	Score
1	1/2	
2	1/2	
3	1	
4	1	
5	1/2	
6	1/2	
7	1/2	
8	1/2	
9	1	
10	1	
11	1	
12	1/2	
13	1/2	
14	1/2	
15	1/2	
Total		/ 100

For Problems 1-3, suppose the position of an airplane at time t is given by the vector function

$$\vec{r}(t) = \left\langle \frac{1}{3}t^3, 5, \frac{1}{2}t^2 \right\rangle.$$

Problem 1. Find the velocity of the airplane at time t.

Problem 2. Find the speed of the airplane when $t = 2$.

Problem 3. Find the length of the airplane's path between $t = 0$ and $t = 1$.

Problem 4. Find parametric equations for the line tangent to the curve defined by the vector function

$$\vec{r}(t) = \langle 1 + \ln(t+1), 2e^t, t\cos 2t \rangle$$

at $(1, 2, 0)$.

For Problems 5-7, consider the following setting.

Eli Manning throws a football at an angle of 32° to the horizontal. It leaves his hand 2 m above the ground. The football lands 40 m from him. Use $g = 9.8\text{m/s}^2$.

For these problems, you do not need to simplify any trigonometric expressions.

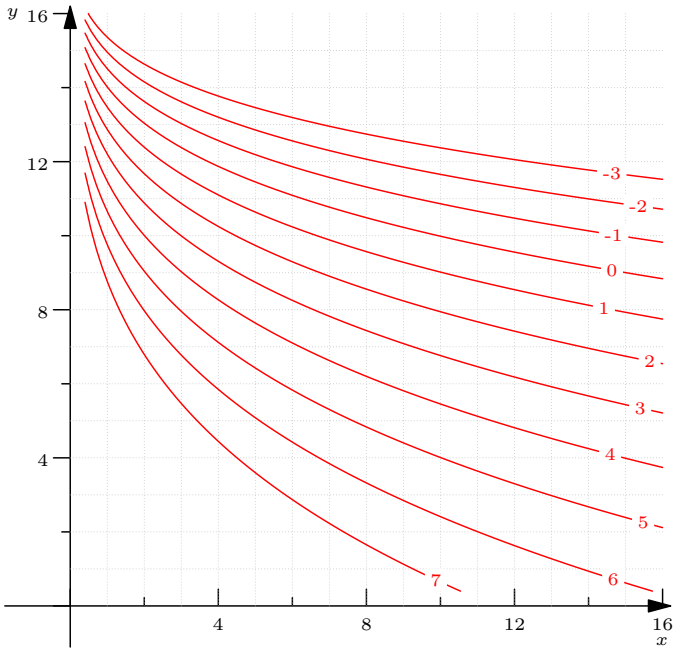
Problem 5. Set up a system of equations with two variables (v_0, t) whose solution gives you the time t at which the ball lands, and the initial speed of the ball v_0. Do not solve the equations.

Suppose the solution to the equations you set up in part 5 is $v_0 = 20$, $t = 2$.

Problem 6. How far is the ball horizontally from Eli 0.5 s after he threw the ball?

Problem 7. How far is the ball vertically from Eli 1 s after he threw the ball?

For Problems 8-11, consider the contour map for a function f shown below.



Problem 8. Estimate $f(3,8)$.

Problem 9. Is $f_x(3,8)$ positive, negative, or zero? Explain why.

Problem 10. Is $f_y(3,8)$ positive, negative, or zero? Explain why.

Problem 11. Is $f_{yy}(3,8)$ positive, negative, or zero? Explain why.

Problem 12. Let $f(x, y) = x \sin xy$. Find f_x.

Problem 13. Let $f(x, y) = \ln(5x^2y + xy^2)$. Find f_y.

Problem 14. Let $f(x, y) = \dfrac{x}{(x + y)^2}$. Find f_{yy}.

Problem 15. Let $f(x, y) = (2x^3 + y^2)^4$. Find f_{xy}.