

- The exam is due on Monday 11/1 ***in class***.
 $\Rightarrow$ *Submission by email or on canvas will **not** be accepted.* $\Leftarrow$
- Please write clearly (if we can't read it, we can't give you credit for it), and submit a clean final draft of your work.
 $\Rightarrow$ *We **don't want to see** all of your erasures and such.* $\Leftarrow$
- Please include your name on each page that you submit and staple the pages together.
- ***For full credit: show and/or explain your work.***
- Partial credit will be given for partially correct work.
- You may use the course textbook, your own notes, resources from the course Canvas (lecture slides, table of integrals, etc.) and a scientific calculator. Nothing else.
- You may not collaborate or seek outside help on the exam.
- To ask for clarification over the weekend, please use the “*clarification questions*” discussion board on canvas.

Problems

1. A particle is moving along a ***helical*** path, with position function

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

- (a) (3 pts) Find the normal and tangential components of acceleration of this particle as a function of t .
- (b) (2 pts) At time $t = 7\pi/3$, the forces acting on the particle (and keeping it on the helical path) disappear, so the particle's acceleration vanishes. What will the position of the particle be at time $t = 13$? Round your answer to 2 decimal points in each coordinate.

Remember: We measure angles in radians.

2. Consider the function $f(x, y, z) = 3xy^2 + x^2z - 2yz^2$.
 - (a) (2 pts) Find the rate of change of f at the point $(3, 3, 3)$ in the direction $\vec{\mathbf{u}} = \langle \frac{2}{3}, \frac{1}{3}, \frac{2}{3} \rangle$.
 - (b) (2 pts) Find the direction in which the rate of change of f is greatest at the point $(2, 2, 2)$. What is the rate of change of f in this direction?
 - (c) (2 pts) Find the equation of the tangent plane to the surface $f(x, y, z) = 2$ at the point $(1, 1, 1)$.
3. (4 pts) Find the critical points of the function $f(x, y) = \frac{1}{2}x^2 + y^3 - 3xy + 2x + 1$ and use the second derivative test to classify the critical values (as relative maxima, relative minima or neither).