The final will cover from Chapter 12 to 15.
There will be an extra review at 4:10pm Sunday December 15.

1. Find the tangent plane of \( xu(x, y) + y(u(x, y)) = 2x^2 \) at the point \((1, 1, 1)\).
Find the tangent plane of \( x^2 + y^2 + 2z^2 = 4 \) at \((1, 1, 1)\).
2. Plot level curves for the function \( z = f(x, y) = 4x^2 + y^2 \).
Plot the level surfaces of the function \( f(x, y, z) = x^2 + y^2 + 4z^2 \).
3. Find the direction in which the function \( z = 2x + \sin(2y) - x \) increases the most from the point \((0, 0)\).
4. Find the directional derivative of \( z = f(x, y) = 4x^2 + y^2 \) in the direction of \( i + j \) at the point \((1, 1)\).
What is the physical meaning of this derivative?
5. Compute: \( (x^2)_x \).
6. Find tangent, normal vector and curvature of the curve:
\( ti + t^2 + i^2 \) k.
7. A particle's acceleration is according to
\( a(t) = \sin(t) i - t j + t^2 k \). Find all its possible vector-valued position function.
8. Find parametrizations of the curves \( 4x^2 + y^2 = 1 \) and \( \frac{1}{4}x^2 + y^2 = 1 \).
9. Find maxima and maximal value of the function \( 2x - y \) inside the unit circle.
10. Find the integral \( \int \int_D z^2 \, dxdy \), where \( D \) is the upper half unit ball \( x^2 + y^2 + z^2 \leq 1, z \geq 0 \).
11. Find maxima and maximal value of the function \( x^2 + 2y \) in the triangle \( x + 3y = 1, y = 0 \) and \( x = 0 \).
12. Find the integral \( \int \int_D z \, dxdy \), where \( D \) is the part of the unit ball \( x^2 + y^2 + z^2 \leq 1 \) and \( x \geq 0, y \geq 0, z \geq 0 \).
13. Find the extrema of the function \( x^2y \) in the triangle bounded by the \( x - axis \)
and \( y - axis \) and the line \( x + y = 1 \).
14. Compute \( \int_C yz \, dx + zdy \), where \( C \) is the upper half disk.
15. Compute the divergence and curl of the vector fields \( x^2 yi + \cos(x + y)j + zk \). The physical meaning of divergence is the density of the source of the vector field and that for curl is the vector valued circulation density.
16. Compute \( \int_C yz \, dx + zdy \), where \( C \) is the counterclockwise unit circle.
17. Compute \( \int_S x^2 \, ds \), where \( S \) is the upper half circle.
18. Compute the center of mass of unit circle with density \( d(x, y) = x^2 \).
19. Write down the change of variable formulae for
spherical and cylindrical coordinates.

20. Compute the integral
\[ \iint_{x^2+y^2 \leq 4} (x+y^2) \, dx \, dy. \]

21. Compute \( \int \int_{\Sigma} F \cdot \mathbf{n} \, dS \) where \( \Sigma \) is the region bounded by the upper half sphere
and \( F = xy^2i + (x+y)j + zk. \)

22. Compute \( \int_{C} F \cdot dr \), where \( F = x^2yi + (x+y)j + zk \) and \( C \) is the intersection of the unit sphere and the plane \( x = z \), with the right hand orientation.

23. Compute \( \int \int_{\Sigma} F \, dS \) where \( \Sigma \) is the region bounded by the upper half sphere
and \( F = z. \)

24. Approximate \( \sqrt{99} \) and \( \sin(46^\circ) \). You have to show the formula. An answer from calculate will yield 0 point.

25. Find the maximum of \( xyz \) if \( x + y + z = 1 \) and positive.