Answer ALL questions (10 points each). Show all work.

1. (a) Find an equation of the plane containing the points $(1, 0, -1)$, $(2, -1, 0)$ and $(1, 2, 3)$.

(b) Find parametric equations for the line through $(5, 8, 0)$ and parallel to the line through $(4, 1, -3)$ and $(2, 0, 2)$.

(c) Is the vector $\mathbf{v} = (2, 0, 2)$ parallel, perpendicular or neither to the plane $z = x + 2y$?

2. After drifting, the height $h$ in inches of the snow at point $(x, y)$ in a parking lot is $h(x, y) = 4 + x^2 - \ln(y^2 + 1)$.

(a) Find the rate the height of the snow at $(3, 1)$ changes per unit distance traveled in the direction towards $(4, 0)$.

(b) A person walking in the lot is at position $(x(t), y(t)) = (2t, \sin t)$ at time $t$. Find the rate at which the height of snow the person is walking in changes per unit time at $t = \pi/2$.

3. Find all local maxima, local minima and saddle points of the graph of $f(x, y) = 2x^4 - x^2 + 3y^2$.

4. Find the mass of a lamina that occupies the region above the $x$-axis and between the circles $x^2 + y^2 = 1$ and $x^2 + y^2 = 16$ and has density $\delta(x, y) = \frac{1}{x^2 + y^2}$ at each point $(x, y)$.

5. (a) Find the volume bounded by $x = 2$, $y = 0$, $y = x^2$, $z = 1$ and $z = x + 2$.

(b) Find an equation of the tangent plane to the graph of $x^3 + y^2 - z = 2$ at the point $(1, 2, 3)$.

6. State, for each series, whether it converges absolutely, converges conditionally or diverges. Name a test which supports each conclusion and show the work to apply the test.

(a) $\sum_{n=0}^{\infty} \frac{(-1)^n n}{3n + 1}$

(b) $\sum_{n=0}^{\infty} \frac{(-1)^n 5^n}{3^n}$

(c) $\sum_{n=0}^{\infty} \frac{(-1)^n}{3n + 1}$

7. (a) Find the interval of convergence of the series $\sum_{n=0}^{\infty} \frac{(x - 2)^n}{(n + 2)3^n}$.

Remember to check the endpoints, if applicable.

(b) Find the limit or show it does not exist: $\lim_{(x, y) \to (0, 0)} \frac{x^2 + y^4}{x^4 + y^2}$

8. (a) Find a unit vector in the direction of the tangent vector at the point $(5, 1, 0)$ to the curve with vector representation $\mathbf{r}(t) = (2t + 7, e^{2t+2}, t^3 + t^2)$.

(b) Graph the equation $x^2 + 2x + 9y^2 + 9z^2 = 8$, labelling the coordinates of the center and any one of the vertices.
9. (a) Write an iterated integral, using either spherical or cylindrical coordinates, to evaluate \( \iiint_E f \, dV \), where \( E \) is the hemisphere \( \{(x, y, z) : x^2 + y^2 + z^2 \leq 4, z \geq 0\} \).

**Note:** The function is not specified, so calculation of the iterated integral is not possible.

(b) Use differentials (linear approximation) to approximate \( \frac{10.1}{\sqrt{3.8}} \).

10. (a) Let \( f(x) = \frac{1}{1 + 2x} \).

(i) Find the first four terms of the Maclaurin series (i.e., the series centered at 0) representation of \( f(x) \).

(ii) Use the result in (i) to find \( f(.01) \) with an error less than or equal .001. Justify that your answer has the required accuracy.

(b) Find the surface area of the portion of the surface \( z = x^2 + y^2 \) which is inside the cylinder \( x^2 + y^2 = 1 \).