

1. Find an equation for the plane that passes through $(1, 2, -2)$ and that contains the line $\frac{x}{2} = y - 3 = \frac{z - 1}{3}$.

18 pts

(OVER)

2. Write the equation $4y^2 + z^2 - x - 16y - 4z + 20 = 0$ in standard form for a quadric surface, classify the surface, and sketch it. Identify the vertex or center point and the axis of symmetry.

18 pts

3. For the curve $\mathbf{r}(t) = \langle 1 + t^3, t + t^2, 0 \rangle$, find (a) the unit tangent vector and (b) the curvature. Put boxes around your answers.

11 pts

4. Let $R = \ln(u^2 + v^2 + w^2)$, $u = x + 2y$, $v = 2x - y$, $w = 2xy$. Find $\frac{\partial R}{\partial y}$ when $x = y = 1$.

7 pts

5. Find the **exact** directional derivative of $f(x, y) = \sqrt{5x - 4y}$ at the point $(4, 1)$ in the direction indicated by the angle $\theta = -\pi/6$.

7 pts

(OVER)

6. Let $f(x, y) = \ln(xy^2)$. Find (a) the maximum rate of change of f at the point $(1, -2)$ and (b) the direction in which it occurs. Put boxes around your answers.

7 pts

Let $f(x, y) = (x^2 + y)e^{y/2}$. Find the critical point(s) of f and classify each as a local maximum, local minimum, or saddle point.

12 pts

7. Fully set up an iterated integral for the (SURFACE) AREA of the part of the sphere $x^2 + y^2 + z^2 = a^2$ that lies within the cylinder $x^2 + y^2 = ax$ and above the xy -plane. **Do not evaluate the integral.**

18 pts

8. **Find the volume** of the solid E that lies above the cone $z = \sqrt{x^2 + y^2}$ and below the sphere $x^2 + y^2 + z^2 = 1$.

18 pts

(OVER)

9. Evaluate $\int_C \mathbf{F} \cdot d\mathbf{r}$, where $\mathbf{F} = \langle y^2 \cos x, x^2 + 2y \sin x \rangle$, and C is the triangle from $(0, 0)$ to $(2, 6)$ to $(2, 0)$ to $(0, 0)$.

14 pts

10. Evaluate $\int_C x^3 z \, ds$, where C is $x = 2 \sin t$, $y = t$, $z = 2 \cos t$, $0 \leq t \leq \pi/2$.

10 pts

11. Evaluate $\int_C \mathbf{F} \cdot d\mathbf{r}$, where $\mathbf{F} = e^z\mathbf{i} + xz\mathbf{j} + (x + y)\mathbf{k}$, and C is given by $\mathbf{r}(t) = t^2\mathbf{i} + t^3\mathbf{j} - t\mathbf{k}$, $0 \leq t \leq 1$.

10 pts

12. Find the work done by the force field $\mathbf{F}(x, y) = (y^2/x^2)\mathbf{i} - (2y/x)\mathbf{j}$ in moving an object from $P(1, 1)$ to $Q(4, -2)$.

10 pts

(OVER)

13. **Extra credit:** Find (a) the curl and (b) the divergence of the vector field $\mathbf{F}(x, y, z) = \cos xz\mathbf{j} - \sin xy\mathbf{k}$.

8 pts