1. Find the local extrema/saddle points for $f(x,y) = x^3 - 3x + 3xy^2$
2. Find the absolute maximum and minimum values of the function $f(x,y) = x^2 + 2xy + 3y^2$ over the set D, where D is the closed triangular region with vertices $(-1,1)$, $(2,1)$, and $(-1,-2)$.
3. Find the gradient vector field of the function $f(x,y,z) = xy^2 - yz^3$.
4. Evaluate the line integral $\int_C x^3 z ds$ if C is given by $x = 2\sin t$, $y = t$, $z = 2\cos t$, $0 \le t \le \pi/2$.
5. Evaluate $\int_C y dx + z dy + x dz$ if C consists of the line segments from (0,0,0) to (1,1,2) and from (1,1,2) to (3,1,4).
6. Evaluate $\int_C \mathbf{F} \cdot d\mathbf{r}$ where $\mathbf{F}(x,y) = x^2 y\mathbf{i} + e^y\mathbf{j}$ and C is given by $\mathbf{r}(t) = t^2\mathbf{i} - t^3\mathbf{j}$, $0 \le t \le 1$.
7. Show that $\mathbf{F}(x,y) = (2x + y^2 + 3x^2 y)\mathbf{i} + (2xy + x^3 + 3y^2)\mathbf{j}$ is conservative vector field. Use this fact to evaluate $\int_C \mathbf{F} \cdot d\mathbf{r}$ if C is the arc of the curve $y = x\sin x$ from (0,0) to $(\pi, 0)$.
8. Show that $\mathbf{F}(x,y,z) = yz(2x+y)\mathbf{i} + xz(x+2y)\mathbf{j} + xy(x+y)\mathbf{k}$ is conservative vector field. Use this fact to evaluate $\int_C \mathbf{F} \cdot d\mathbf{r}$ if C is given by $\mathbf{r}(t) = (1+t)\mathbf{i} + (1+2t^2)\mathbf{j} + (1+3t^3)\mathbf{k}$, $0 \le t \le 1$.
9. Given the line integral $I = \oint_C 4x^2 y\, dx - (2+x)\, dy$ where C consists of the line segment from $(0,0)$ to $(2,-2)$, the line segment from $(2,-2)$ to $(2,4)$, and the part of the parabola $y = x^2$ from $(2,4)$ to $(0,0)$. Use Green's theorem to **evaluate** the given integral and **sketch** the curve C indicating the **positive direction.**
10. Find curl $\mathbf{F}$ and div $\mathbf{F}$ if $\mathbf{F} = x^2 z\mathbf{i} + 2x\sin y\mathbf{j} + 2z\cos y\mathbf{k}$
11. Find the area of the surface with parametric equations $x = u^2$, $y = uv$, $z = \frac{1}{2}v^2$, $0 \le u \le 1$, $0 \le v \le 2$.
12. Find the area of the part of the paraboloid $z = x^2 + y^2$ that lies inside the cylinder $x^2 + y^2 = 4$.
13. Find the mass of a thin funnel in the shape of a cone $z = \sqrt{x^2 + y^2}$, $1 \le z \le 4$ if its density function is $\rho(x,y,z) = 10 - z$.
14. Evaluate $\iint_S xy\, dS$ if S is the boundary of the region enclosed by the cylinder $x^2 + z^2 = 1$ and the planes $y = 0$ and $x + y = 2$.
15. Evaluate $\iint_S yz\, dS$ if S is the surface given by $\mathbf{r}(u,v) = \langle uv, u+v, u-v \rangle$, $u^2 + v^2 \le 1$.
16. Evaluate $\iint_S \mathbf{F} \cdot d\mathbf{S}$, if
   (a) $\mathbf{F}(x,y,z) = \langle x^2 y, -3xy^2, 4y^3 \rangle$ and S is the part of the elliptic paraboloid $z = x^2 + y^2 - 9$ that lies below the rectangle $0 \le x \le 2$, $0 \le y \le 1$ and has downward orientation.
   (b) $\mathbf{F}(x,y,z) = \langle x, y, 5 \rangle$ and S is the boundary of the region enclosed by the cylinder $x^2 + z^2 = 1$ and the planes $y = 0$ and $x + y = 2$.
17. Use Stokes' Theorem to evaluate $\oint_C \mathbf{F} \cdot d\mathbf{r}$ where $\mathbf{F}(x,y,z) = < 3z, 5x, -2y >$ and C is the ellipse in which the plane $z = y + 3$ intersects the cylinder $x^2 + y^2 = 4$, with positive orientation as viewed from above.

18. Use Stokes' Theorem to evaluate $\iint_S \operatorname{curl}(\mathbf{F}) \cdot d\mathbf{S}$ for the vector field $\mathbf{F}(x, y, z) = \langle ze^y, x\cos y, xz\sin y\rangle$ and the hemisphere $y = \sqrt{4 - x^2 - z^2}$ oriented in the direction of the positive y-axis.

19. Use the Divergence Theorem to find the flux of the vector field $\mathbf{F} = \langle x, y, 1\rangle$ across the surface S which is the boundary of the region enclosed by the cylinder $y^2 + z^2 = 1$ and the planes $x = 0$ and $x + y = 5$.