1. Let $T(x,y,z) = x^3 + y^4 - xyz^2$. Determine whether T is increasing or decreasing at the point $(1,-2,1)$ in the direction of the vector $\mathbf{u} = (1/\sqrt{3}, -1/\sqrt{3}, -1/\sqrt{3})$.

2. The level surface $G(x,y,z) = (x-2)^4 + (y-2)^4 + (z-1)^2 = 3$ and graph of $f(x,y) = 4 - x^2 - y^2$ are two surfaces which intersect at the point $(1,1,2)$. Determine whether or not they are tangent at that point, that is, whether they have the same tangent plane.

3. Find the area of the region enclosed by the curve $r^2 = 4\cos 2\theta$. (The curve looks roughly like ∞, with the center point positioned at the orgin.)

4. Evaluate $\int_0^4 \int_{\sqrt{y}}^2 e^{x^3}\, dx\, dy$.

5. Let W be the region bounded below by the paraboloid $z = x^2 + y^2$ and above by the plane $z = 2y$. Set up an iterated integral which gives the value of the triple integral $\int\int\int_W xyz\, dV$. You do not need to evaluate the iterated integral, but do find all the limits of integration.

6. Let D be the region consisting of all the points (x,y) where $1 \le x^2 + y^2 \le 2$ and $y \ge 0$. Evaluate the double integral $\int\int_D (1 + x^2 + y^2)\, dA$.

7. Consider the vector field $\mathbf{F}(x,y,z) = (2x, 3y^2 z, y^3 + \sin z)$.
   (a) Compute the curl, $\nabla \times \mathbf{F}$.
   (b) Compute $\operatorname{div} \mathbf{F}$.

8. Consider the path $\mathbf{c}(t) = (\sin(5t), \sqrt{3}\sin(5t), 2\cos(5t))$. For which values of α, β, γ is $\mathbf{c}(t)$ a flowline for the vector field $\mathbf{F}(x,y,z) = (\alpha z, \beta z, \gamma x)$?