1. Let $F(x,y,z) = (x+3z, xy^2, y)$ be a vector field, and let $C(t) = (2t, t^3, t+t^2)$ be a parametrized curve with $t \in [0,1]$. Calculate the flow of F along C in two ways: (i) integrating the flow form for F over C, and (ii) using the classical formula for $\int_C F \cdot dC$.

2. Let $F(x,y,z) = (y^2, z, 3x)$ be a vector field, and let $S(u,v) = (u, v, uv)$ be a parametrized curve with $(u,v) \in [0,1]^2$. Calculate the flux of F through S in two ways: (i) integrating the flux form for F over S, and (ii) using the classical formula for $\int_C F \cdot \vec{n}$.

3. Thinking of each of the following 1-forms in $\mathbb{R}^3$ as flow forms, find the corresponding vector fields.
   (a) $\omega = x\,dx + \ln(x^2+z^2)\,dy + (y+xz)\,dz$.
   (b) $\eta = \cos(xy)\,dx + \sin(yz)\,dz$.

4. Thinking of each of the following 2-forms in $\mathbb{R}^3$ as flux forms, find the corresponding vector fields.
   (a) $\eta = -dx \wedge dy + xy\,dx \wedge dz$.
   (b) $\omega = dx \wedge (y\,dy - (x+z^2)\,dz)$.

5. (a) Give an concrete example of a 0-form, η, in $\mathbb{R}^3$, i.e., and element $\eta \in \Omega^0\mathbb{R}^3$.
   (b) Interpret integration of $d\eta$ in terms of classical vector calculus. What does Stokes' theorem say in this context?

6. Let ϕ be a function on $\mathbb{R}^3$, and let F be a vector field in $\mathbb{R}^3$. Describe $\operatorname{grad}(\phi)$, $\operatorname{curl}(F)$, and $\operatorname{div}(F)$ using flow forms, flux forms, and the exterior derivative operator, d.

7. (a) State Stokes' theorem in terms of differential forms.
   (b) Starting with $\omega \in \Omega^i\mathbb{R}^3$ for each of $i = 0, 1, 2$, give a classical/physical interpretation of Stokes' theorem.

8. What does the fact that $d^2 = 0$ say in terms of grad, curl, and div?

9. Let ω be a k-form. When is it true that $d\omega = 0$ implies there exists a $(k-1)$-form, λ such that $\omega = d\lambda$? What is the implication for grad, for curl, and for div?