1. Let
$$\mathbf{a} = \hat{\mathbf{i}} + \hat{\mathbf{j}} - 2\hat{\mathbf{k}}, \quad \mathbf{b} = 3\hat{\mathbf{i}} - 2\hat{\mathbf{j}} + \hat{\mathbf{k}}, \quad \mathbf{c} = \hat{\mathbf{j}} - 5\hat{\mathbf{k}}$$
Calculate

   (a) $2\mathbf{a} + 3\mathbf{b}$
   (b) $|\mathbf{b}|$
   (c) $\mathbf{a} \cdot \mathbf{b}$
   (d) $\mathbf{a} \times \mathbf{b}$
   (e) $|\mathbf{b} \times \mathbf{c}|$
   (f) $\mathbf{a} \cdot (\mathbf{b} \times \mathbf{c})$
   (g) $\mathbf{c} \times \mathbf{c}$
   (h) $\mathbf{a} \times (\mathbf{b} \times \mathbf{c})$
   (i) $\text{comp}_{\mathbf{a}}\mathbf{b}$
   (j) $\text{proj}_{\mathbf{a}}\mathbf{b}$
   (k) The angle between $\mathbf{a}$ and $\mathbf{b}$

2. Find the distance from the origin to the line $\mathbf{r}(t) = \langle 1 + t, 2 - t, -1 + 2t \rangle$

3. (a) Find an equation of the plane that passes through the points $A(2, 1, 1)$, $B(-1, -1, 10)$, $C(1, 3, -4)$.
   (b) Find symmetric equations for the line through B that is perpendicular to the plane in (a).
   (c) A second plane passes through $P(2, 0, 4)$ and has normal vector $\langle 2, -4, -3 \rangle$. Find the acute angle between the two planes.
   (d) Find parametric equations for the line of intersection of the two planes.

4. Let C be the curve with equations $x = 2 - t^3$, $y = 2t - 1$, $z = \ln(t)$.
   (a) Find the point where C intersects the xz-plane.
   (b) Find the parametric equations of the tangent line at $(1, 1, 0)$.

5. A particle starts at the origin with initial velocity $\hat{\mathbf{i}} - \hat{\mathbf{j}} + 3\hat{\mathbf{k}}$. The acceleration at time t is $\mathbf{a}(t) = 6t\,\hat{\mathbf{i}} + 12t^2\,\hat{\mathbf{j}} - 6t\,\hat{\mathbf{k}}$. Find the position function $\mathbf{s}(t)$.

6. Find all second partial derivatives of $v = r\cos(s + 2t)$.

7. Two legs of a right triangle are measured to be 5 m and 12 m with a maximum possible measurement error of 0.2 cm. Use differentials to estimate the maximum error in the calculated (a) area and (b) hypotenuse of the triangle.

8. (a) When is the directional derivative of f a maximum?
   (b) When is it a minimum?
   (c) When is it zero?
   (d) When is it half of its maximum value?

9. Find parametric equations of the tangent line at the point $P(-2, 2, 4)$ to the curve of intersection of the surface $z = 2x^2 - y^2$ and the plane $z = 4$.

10. Find the local extrema and saddle points of $f(x, y) = (x^2 + y)e^{y/2}$.

11. Find the absolute extrema of $f(x, y) = e^{-(x^2+y^2)}(x^2 + 2y^2)$ on the disk $x^2 + y^2 \leq 4$.