Basics

- dot product: $\underline{a} \cdot \underline{b} = a_1 b_1 + a_2 b_2 + ... = |\underline{a}||\underline{b}| \cos\theta$, $W = \underline{F} \cdot \underline{d}$ where F is force and d is distance
- Cross Product: $\underline{v} \times \underline{w} = \begin{vmatrix}]i & -j & k \\ v_1 & v_2 & v_3 \\ w_1 & w_2 & W_3 \end{vmatrix}$
- The area of the quadrilateral which the vectors are enclosing is the determinant of the cross product
- Vector equation of line : $(x, y, z) = (x_0, y_0, z_0) + t(a, b, c)$; where (a, b, c) is a vector parallel to the line and (x_0, y_0, z_0) is a point on the line
- Standard equation of line/plane: $\underline{n} \cdot ((x, y, z) - (x_0, y_0, z_0)) = 0$, where $\underline{n}$ is a vector normal to the line/plane
- **projection $\underline{\mathbf{a}}$ onto $\underline{\mathbf{b}}$**: $Proj_{\underline{b}}(\underline{a}) = \underline{a}_{\underline{b}} = (\underline{a} \cdot \frac{\underline{a}}{|\underline{b}|}) \frac{\underline{b}}{|\underline{b}|})$

Parametrization

- **Curve**: $R^2 : \underline{r} = (x(t), y(t))$; $R^3 : \underline{r} = (x(t), y(t), z(t))$
- **Tangent line at** $t = t_0$: $L(s) = \underline{r}(t_0) + s\underline{\dot{r}}(t_0)$
- ...

Surfaces and Gradient vectors

- **Common surfaces**:
  - **Bowl/cup**: $z = x^2 + y^2$
  - **Saddle**: $z = x^2 - y^2$
  - **Sphere**: $x^2 + y^2 + z^2 = R^2$