1. (a)

$$(\mathbf{a} - \mathbf{b}) \times (\mathbf{a} + \mathbf{b}) = (\mathbf{a} - \mathbf{b}) \times \mathbf{a} + (\mathbf{a} - \mathbf{b}) \times \mathbf{b}$$
$$= \mathbf{a} \times \mathbf{a} + (-\mathbf{b}) \times \mathbf{a} + \mathbf{a} \times \mathbf{b} + (-\mathbf{b}) \times \mathbf{b} \quad \textbf{(1 point)}$$
$$= (\mathbf{a} \times \mathbf{a}) - (\mathbf{b} \times \mathbf{a}) + (\mathbf{a} \times \mathbf{b}) - (\mathbf{b} \times \mathbf{b})$$
$$= \mathbf{0} - (\mathbf{b} \times \mathbf{a}) + (\mathbf{a} \times \mathbf{b}) - \mathbf{0}$$
$$= (\mathbf{a} \times \mathbf{b}) + (\mathbf{a} \times \mathbf{b})$$
$$= 2(\mathbf{a} \times \mathbf{b}) \qquad\qquad\qquad\qquad\qquad \textbf{(1 point)}$$

(b)

$$\mathbf{a} \times (\mathbf{b} \times \mathbf{c}) + \mathbf{b} \times (\mathbf{c} \times \mathbf{a}) + \mathbf{c} \times (\mathbf{a} \times \mathbf{b})$$
$$= [(\mathbf{a} \cdot \mathbf{c})\mathbf{b} - (\mathbf{a} \cdot \mathbf{b})\mathbf{c}] + [(\mathbf{b} \cdot \mathbf{a})\mathbf{c} - (\mathbf{b} \cdot \mathbf{c})\mathbf{a}] + [(\mathbf{c} \cdot \mathbf{b})\mathbf{a} - (\mathbf{c} \cdot \mathbf{a})\mathbf{b}] \quad \textbf{(1 point)}$$
$$= (\mathbf{a} \cdot \mathbf{c})\mathbf{b} - (\mathbf{a} \cdot \mathbf{b})\mathbf{c} + (\mathbf{a} \cdot \mathbf{b})\mathbf{c} - (\mathbf{b} \cdot \mathbf{c})\mathbf{a} + (\mathbf{b} \cdot \mathbf{c})\mathbf{a} - (\mathbf{c} \cdot \mathbf{a})\mathbf{b}$$
$$= \mathbf{0} \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \textbf{(1 point)}$$

2. span a plane C at the line $L_1 = (2, 0, 1) + \mathbb{R}(2, -1, 0)$ which is parallel to the line $L_2 = (1, -1, 0) + \mathbb{R}(0, 1, 1)$, the normal vector of the plane can be $n = \langle 1, 2, -2 \rangle$ **(1 point)**; choose a point $(1, -1, 0)$ on the line L_2 and a point $(2, 0, 1)$ on the plane C to make a vector $v = \langle 1, 1, 1 \rangle$ **(1 point)**, the distance is the projection of v on n, $d = |\frac{v \cdot n}{|n|}| = |\frac{1 \times 1 + 1 \times 2 + 1 \times (-2)}{\sqrt{1^2 + 2^2 + (-2)^2}}| = \frac{1}{3}$ **(1 point)**.

3. **(0.5 point each)**

   (a) Ellipsoid

   (b) Cone

   (c) Elliptic Paraboloid

   (d) Hyperboloid of One Sheet

   (e) Hyperbolic Paraboloid

   (f) Hyperboloid of Two Sheets