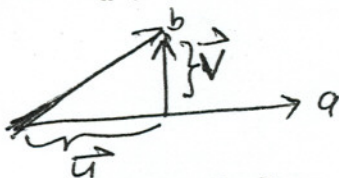9. **(There is no partial credit for this problem. Make sure your answer is correct.)** Let $\vec{a} = 1\vec{i} + 2\vec{j} - 3\vec{k}$ and $\vec{b} = 2\vec{i} - 2\vec{j} + 3\vec{k}$. Find vectors $\vec{u}$ and $\vec{v}$ with $\vec{b} = \vec{u} + \vec{v}$, $\vec{u}$ parallel to $\vec{a}$, and $\vec{v}$ perpendicular to $\vec{a}$.

$$\vec{u} = \text{proj}_{\vec{a}}\,\vec{b} = \frac{\vec{a}\cdot\vec{b}}{\vec{a}\cdot\vec{a}}\,\vec{a} = \frac{2-4-9}{1+4+9}\,\vec{a} = \boxed{\frac{-11}{14}\left(\vec{i} + 2\vec{j} - 3\vec{k}\right)} = \vec{u}$$

$$\vec{v} = \vec{b} - \vec{u} = \frac{1}{14}\left(28\vec{i} - 28\vec{j} + 42\vec{k} + 11\vec{i} + 22\vec{j} - 33\vec{k}\right)$$

$$\boxed{\vec{v} = \frac{1}{14}\left(39\vec{i} - 6\vec{j} + 9\vec{k}\right)}$$

$\vec{u} + \vec{v} = \vec{b}$ ✓
$\vec{u} \parallel \vec{a}$ ✓
$\vec{v} \perp \vec{a}$ ✓

10. Let $f(x,y) = x\cos y + (\ln x)\sin(xy)$. Find f_x.

$$\boxed{f_x = \cos y + (\ln x)y\cos(xy) + \frac{\sin xy}{x}}$$