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Q1

$u = (2,0,1)$
$v = (0,1,1)$
$w = (x,y,z)$

$u \cdot w = 0 \longrightarrow (2,0,1)\cdot(x,y,z) = 2x + z = 0$
$v \cdot w = 0 \longrightarrow (0,1,1)\cdot(x,y,z) = y + z = 0$

$2x + \cancel{z} = y + \cancel{z}$

$2x = y = -z$
$(k) \quad (2k) \quad (-2k) \longrightarrow (1, 2, -2)$

unit vector 1 $\rightarrow \left(\frac{1}{3}, \frac{2}{3}, -\frac{2}{3}\right)$
unit vector 2 $\rightarrow \left(-\frac{1}{3}, \frac{-2}{3}, \frac{2}{3}\right)$

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Q2

a/

$u = (4,2,3,1)$
$a = (2,-2,1,-1)$

$$\text{proj}_a u = \frac{\vec{u}\cdot\vec{a}}{|\vec{a}|}\cdot\frac{\vec{a}}{|\vec{a}|} = \frac{\overbrace{8-4+3-1}^{6}}{\sqrt{10}}\ \frac{(2,-2,1,-1)}{\sqrt{10}}$$

$$= \frac{6}{10}\cdot\vec{a} = \left(\frac{6}{5}, \frac{-6}{5}, \frac{3}{5}, \frac{-3}{5}\right)$$

b/

$$u - \text{proj}_a u = (4,2,3,1) - \left(\frac{6}{5}, \frac{-6}{5}, \frac{3}{5}, \frac{-3}{5}\right)$$

$$= \left(\frac{14}{5}, \frac{16}{5}, \frac{12}{5}, \frac{8}{5}\right)$$

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Q3

a/ Let $A(0,-5,0)$ is a point on $3x - y - z = 5$.
→ Distance between point and equation gives distance between this two planes here.

$A(0,-5,0)$ $\qquad$ $6x - 2y - 2z - 8 = 0$

$$\frac{(0\cdot 6) + (-5\cdot -2) + (0\cdot -2) - 8}{\sqrt{6^2 + (-2)^2 + (-2)^2}} = \frac{2}{\sqrt{44}} = \frac{1}{\sqrt{11}}$$

b/ Let $B(0,0,0)$ is a point on $-x + y + 2z = 0$

$B(0,0,0)$ $\qquad$ $-3x + 3y + 6z$

$$\frac{(0\cdot -3) + (0\cdot 3) + (0\cdot 6)}{\sqrt{(-3)^2 + (3)^2 + 6^2}} = \frac{0}{\sqrt{54}} = 0$$

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Q4

$$x = (t+1)(4,6) + t(-1,0)$$

$$= (4t+4, 6t+6) + (-t, 0)$$

$$= (3t+4, 6t+6)$$

$$= \underbrace{(4,6)}_{\text{point}} + \underbrace{t\,(3,6)}_{\text{parallel vector}}$$

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Q5/

$u = (2,0,-3)$, $(0,0,0)$ is a point on plane,

equation of plane $= (x-x_0, y-y_0, z-z_0)\cdot(a,b,c)$

$\rightarrow (x-0, y-0, z-0)(2,0,-3) = 0$

$\Rightarrow \underbrace{2x}_{3t_1} - \underbrace{3z}_{2t_1} = 0$

$u = (3t, 0, 2t)$

$u = t_1(3,0,2)$

$y = t_1$

$z = t_2$

$x = \frac{3t_2}{2}$

$(x,y,z) = \left(\frac{3t_2}{2}, t_1, t_2\right)$

Parametric Equation :

$(x,y,z) = (0,0,0) + t_1(0,1,0) + t_2(3/2, 0, 1)$

Q6

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$R_2 - R_1/2 \to R_2$, $R_3 + R_1 \to R_3$

(a) =

$x_3 = t$, $x_2 = k$ $\to$ $x_1 = t/3 - 2k/3$

$(x_1, x_2, x_3) = t\,(1/3, 0, 1) + k\,(-2/3, 1, 0)$

(b) $x_1 = 1$, $x_2 = 0$, $x_3 = 1$

$(6, 4, -2) \cdot (1, 0, 1) = 6 \cdot 1 + 4 \cdot 0 - 2 \cdot 1 = 4$

$\to$ $x_1 = 1$, $x_2 = 0$, $x_3 = 1$ is a solution of nonhomogenous system.

(c) $(x_1, x_2, x_3) = t\left(\frac{1}{3}, 0, 1\right) + k\left(\frac{-2}{3}, 1, 0\right) + (1, 0, 1)$

$x_1 = \frac{t}{3} - \frac{2k}{3} + 1$

$x_2 = k$

$x_3 = t + 1$

(d) $(+6, 4, -2) \cdot \left(\frac{t}{3} - \frac{2k}{3} + 1, k, k+1\right)$

$= 2t - 4k + 6 + 4k - 2t - 2 = 4$

same result