

$u = (2, 7, -3, -6)$   
 $v_1 = (1, 1, -1, 2)$   
 $v_2 = (1, 1, -3, 3)$

$u \cdot v_1 = 0$   
 $u \cdot v_2 = 0$   
 $v_1 \cdot v_2 = 11$   
 $v_1 \cdot v_1 = 7$   
 $v_2 \cdot v_2 = 20$

$u = t \cdot v_1 + s \cdot v_2 + w$   
 $0 = 7t + 11s$   
 $0 = 11s + 20w$   
 $t, s = 0$

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$u(1,1,0) = (1,1,0)$   
 $u(1,1,0) = (1,1,0)$   
 $u(1,1,0) = (3,3,-1)$

$u \cdot v = (1,1,0) \cdot (1,0,-1) = (1,3,-1)$

$\begin{pmatrix} 1 & 1 & 0 \\ 1 & 1 & 0 \\ 3 & 3 & -1 \end{pmatrix} \sim \begin{pmatrix} 1 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix}$

$\text{Im } u = \text{span}\{v_1, v_2\}$

$u(1,1,0) = (2,2,-1)$   
 $u(1,1,0) = (1,1,0)$   
 $u(0,0,0) = (0,0,0)$

$u(1,1,0) = a(1,1,1) + b(1,1,0) + c(1,1,0)$

$u(1,1,0) = 0 \cdot u(1,1,0) + 1 \cdot u(1,1,0) - 1 \cdot u(1,1,0)$   
 $= (1,1,0) - (1,1,0) = (0,0,0)$

$u(1,1,0) = a(1,1,0) + b(1,1,0) + c(1,1,0)$

$u(1,1,0) = 1 \cdot u(1,1,0) - 1 \cdot u(1,1,0) + 0 \cdot u(1,1,0)$   
 $= (1,1,0) - (1,1,0) = (0,0,0)$

$u(1,1,0) = \begin{pmatrix} 1 & 1 & 0 \\ 1 & 1 & 0 \\ 3 & 3 & -1 \end{pmatrix} \begin{pmatrix} a \\ b \\ c \end{pmatrix}$

$u(1,1,0) = (2, 2, -1) = (2x_1 - x_2, 3x_1 - 3x_2 + x_3, -x_1 + x_3)$

$\text{ker } u = \{x_1 = x_2 = 0, x_3 = 0\}$

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$u(x_1, x_2, x_3) = (2x_1 - x_2, 3x_1 - 3x_2 + x_3, -x_1 + x_3)$

$(a, b, c)$

$u(x_1, x_2, x_3) = (a, b, c)$

$2x_1 - x_2 = a$   
 $3x_1 - 3x_2 + x_3 = b$   
 $-x_1 + x_3 = c$

$2x_1 - x_2 = 2$   
 $3x_1 - 3x_2 + x_3 = 1$   
 $-x_1 + x_3 = 1$

$u(u) = (2, 1, 1)$

$u(a, b, c) = (2, 1, 1)$

$u(a, b, c) = t(1, 1, 1) + s(1, 1, 0) + r(1, 0, 0)$

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$P = \alpha$   
 $P \parallel Q$   
 $P \perp Q$   
 $M \in P$

$P: x + y - z + 7$   
 $Q: [0, 0, 0] + t(1, 1, 3)$

$M[1, 1, 3]$

$J: x + y - z + c = 0$   
 $c = 2$

$J: x + y - z + 2 = 0$

$\alpha_{2P}: t + t - 3t + 2 = 0$   
 $t + t = 2$   
 $t = 2$

$X[2, 2, 6]$

$\Rightarrow MX$

1. T  
 2. qm  
 3. xm

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$N_1: 2x + x_2 - x_3 = 1$   
 $N_2: 3x_1 - x_2 + x_3 - x_4 = 2$

$\begin{pmatrix} 2 & 1 & -1 & 0 & 1 \\ 3 & -1 & 1 & -1 & 2 \end{pmatrix} \sim$

$\begin{pmatrix} 2 & 1 & -1 & 0 & 1 \\ 0 & -5 & -1 & -2 & 1 \end{pmatrix}$

$x_1 = t$   
 $x_3 = s$

$x_2 = \frac{1 + 2t + s}{5}$   
 $x_4 = 1 + s - \frac{1 + 2t + s}{5}$

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