

```
> restart: with(linalg):
Warning, the protected names norm and trace have been redefined and
unprotected
```

Los datos del problema son:

```
> u1:=[1,2,3,0,4];
    u2:=[1,1,1,1,1];
    u3:=[1,0,1,0,1];
    u4:=[2,1,4,-1,5];

u1 := [1, 2, 3, 0, 4]
u2 := [1, 1, 1, 1, 1]
u3 := [1, 0, 1, 0, 1]
u4 := [2, 1, 4, -1, 5]
```

**a) y b)**

```
> A:=concat(u1,u2,u3,u4);

A := 
$$\begin{bmatrix} 1 & 1 & 1 & 2 \\ 2 & 1 & 0 & 1 \\ 3 & 1 & 1 & 4 \\ 0 & 1 & 0 & -1 \\ 4 & 1 & 1 & 5 \end{bmatrix}$$


> rank(A);

3

> det(submatrix(A, [1,2,3], [1,2,3]));

-2
```

Los vectores u1, u2, u3 forman una base de W y la dimensión de W es 3.

**c)**

```
> B:=concat([x,y,z,t,v],u1,u2,u3);

B := 
$$\begin{bmatrix} x & 1 & 1 & 1 \\ y & 2 & 1 & 0 \\ z & 3 & 1 & 1 \\ t & 0 & 1 & 0 \\ v & 4 & 1 & 1 \end{bmatrix}$$


> ec1:=0=det(submatrix(B, [1,2,3,4], [1,2,3,4]));
    ec1 := 0 = -2 x - 2 y + 2 z + 2 t

> ec2:=0=det(submatrix(B, [1,2,3,5], [1,2,3,4]));
    ec2 := 0 = x - 3 z + 2 v

> W:={ec1,ec2};

W := {0 = x - 3 z + 2 v, 0 = -2 x - 2 y + 2 z + 2 t}
```

**d)**

```
> u5:=[1,2,1,3,4];

u5 := [1, 2, 1, 3, 4]
```

```
[ > rank(concat(u1,u2,u3,u5));
```

4

```
[ El vector u5 no pertenece a W
```

**e)**

```
[ > u6:=[0,3,0,3,0];
```

$u6 := [0, 3, 0, 3, 0]$

```
[ > rank(concat(u1,u2,u3,u6));
```

3

**f)**

```
[ > concat(u1,u2,u3,u5);
```

$$\begin{bmatrix} 1 & 1 & 1 & 1 \\ 2 & 1 & 0 & 2 \\ 3 & 1 & 1 & 1 \\ 0 & 1 & 0 & 3 \\ 4 & 1 & 1 & 4 \end{bmatrix}$$

```
[ > 0=det(concat([x,y,z,t,v],u1,u2,u3,u5));
```

$0 = -7x - 6y + 9z + 6t - 2v$

**g)**

```
[ > w1:=[1,2,0,5,4]; w2:=[3,3,4,4,9];
```

$w1 := [1, 2, 0, 5, 4]$

$w2 := [3, 3, 4, 4, 9]$

```
[ > rank(concat(u1,u2,u3,w1,w2));
```

4

```
[ El espacio generado por w1 y w2 no es un subespacio complementario de W
```

**h)**

```
[ > rank(concat(u1,u2,u3,w1,u5));
```

5

```
[ >
```

```
[ Los vectores w1 y u5 forman una base del espacio complementario de W
```