2.3

3.

(a)



(b)



9.



12.

Suppose that there exist x1, x2 that T(x1)=T(x2) but x1≠x2.

T(x1)=T(x2) so UT(x1)=U(T(x1))=U(T(x2))

so UT is not one-to-one

U doesn't have to be one-to-one.

suppose T((a,b))=(a+b,b) and U((a,b))=(a,-a) (notice that U((1,0))=U((1,1)))

UT((a,b))=(a+b,a-b)

U doesn't have to be one-to-one when UT is one-to-one.

(b)

if U is not onto, there exists z1 in Z that has no mapping from W.

since range(T)⊆W, there can't be v1 that maps to z1 by UT.

let T((a,b))=(a,b,0), U((a,b,c))=(a,b)

UT((a,b))=(a,b)

T doesn't have to be onto.

(c)

UT(x)=0

then T(x)=0

then x=0

so UT is one-to-one.

for all z in Z, there exists w that's U(w)=z since U is onto.

for all w in U there exists v that's T(v)=w

so for all z in Z there exists v that's UT(v)=z

14.

(a)



(b)



(c)

since by a, (wA)^T =A^Tw^T is a linear combination of the columns of A^T with the coefficients in the linear combination being the coordinates of w^T.

so wA is the linear combination of the rows of A, with the coefficients of the linear combinatoin being the coordinates of w.

(d)

thinking of (AB)^T=B^TA^T where the jth column is a linear combination of the columns of B^T with the coefficients in the linear combination being the entries of column j of A^T,

the jth row is a linear combination of the rows of B with the coefficients in the linear combination being the entries of row j of A.

15.

u\_j is the jth column of MA

v\_j is the jth column of A

