# ECE 417 - Introduction to Robotics

## Notes

Matrix review:

Multiplication:

$$\overset{R}{\begin{bmatrix} r_{11} & r_{12} \\ r_{21} & r_{22} \\ r_{31} & r_{32} \end{bmatrix}} \overset{S}{\begin{bmatrix} s_{11} & s_{12} & s_{13} & s_{14} \\ s_{21} & s_{22} & s_{23} & s_{24} \end{bmatrix}} = \overset{T}{\begin{bmatrix} t_{11} & t_{12} & t_{13} & t_{14} \\ t_{21} & t_{22} & t_{23} & t_{24} \\ t_{31} & t_{32} & t_{33} & t_{34} \end{bmatrix}}$$

where $t_{ij} = r_{row\,i} \cdot s_{col\,j}$ (dot product)

sizes: $\overset{R}{3\text{x}2}$ times $\overset{S}{2\text{x}4}$ = 3x4

Remember: Row, Column (RC)

Note: Matrix multiplication does not commute:

In general $AB \neq BA$

But associate property holds:

$$(AB)C = A(BC)$$

For many matrices $A$ (i.e., non-singular matrices) there exists an inverse $A^{-1}$ such that

$$AA^{-1} = A^{-1}A = I$$

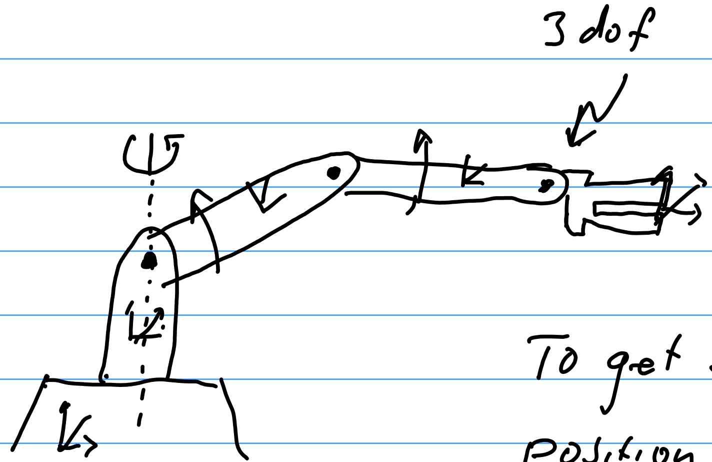
Where I is an identity matrix. E.g.,

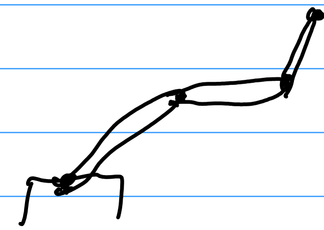
$$I_{33} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Matrix transpose: $A^T$ interchanges rows and columns

$$\begin{bmatrix} r_{11} & r_{12} \\ r_{21} & r_{22} \\ r_{31} & r_{32} \end{bmatrix} \rightarrow \begin{bmatrix} r_{11} & r_{21} & r_{31} \\ r_{12} & r_{22} & r_{32} \end{bmatrix}$$

Degrees of freedom



To get to any
position and orientation
⇒ 6 dof