MEEN 363-501; Exam 1 Summary Sheet (**Exam 1 is closed books and notes, no "cheat" sheets**)

Coordinate System	Unit Vectors*		Position*		Velocity*		Acceleration*	
Cartesian	**I**	**J**	X	Y	$v_X = \dot{X}$	$v_Y = \dot{Y}$	$a_X = \ddot{X}$	$a_Y = \ddot{Y}$
Polar	$\mathbf{e_r}$	$\mathbf{e_\theta}$	r	θ	$v_r = \dot{r}$	$v_\theta = r\dot{\theta}$	$a_r = \ddot{r} - r\dot{\theta}^2$	$a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta}$
Path	$\mathbf{e_t}$	$\mathbf{e_n}$	S *(along path)*	----	$v_t = \dot{S} = v$	$v_n = 0$	$a_t = \dot{v} = \ddot{S}$	$a_n = \frac{v^2}{\rho}$

NOTE: **Understanding how <u>the positive direction</u>** for the **unit vectors are defined** is critical and a must.

* You are responsible for knowing these definitions/terms at the exam. **<u>These equations/relations WILL NOT be provided</u>**.

Transformations:

1) To go from Cartesian to Polar or vice versa, require θ. $\tan\theta = \frac{Y}{X}$

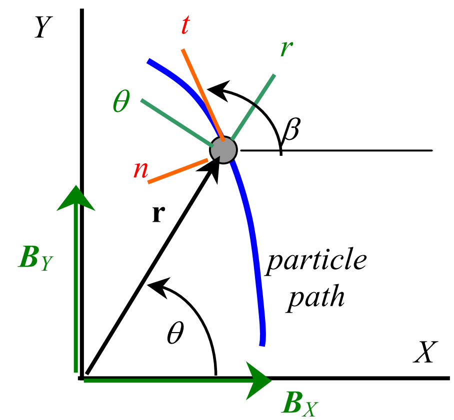
2) To go from Cartesian to Path or vice versa, require β. $\tan\beta = \frac{v_Y}{v_X} = \frac{dY}{dX}$

Make sure that you understand what **quadrant** a vector lies in when interpreting the returned value from the *tan* function. Also make sure that you remember if you are in radians or degrees

3) There is not a convenient transform to get from Polar to Path or vice-versa. It is best to convert to Cartesian, and then to convert those results to the desired reference system.

$$\begin{bmatrix} B_r \\ B_\theta \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} B_X \\ B_Y \end{bmatrix}; \quad \begin{bmatrix} B_t \\ B_n \end{bmatrix} = \begin{bmatrix} \cos\beta & \sin\beta \\ -\sin\beta & \cos\beta \end{bmatrix} \begin{bmatrix} B_X \\ B_Y \end{bmatrix}$$

These transformations require that both systems be defined according to the right hand rule for Cartesian systems: X→Y=>+Z, r→θ=>+Z, *t*→*n*=>+Z



NOTE: It is important to understand the relative relationship between the defined reference systems used to obtain the above transformations. If the orientation is different, these relations need to be modified accordingly.

Radius of curvature: $\frac{1}{\rho} = \frac{|Y''|}{\left(1+Y'^2\right)^{\frac{3}{2}}}$; ρ = radius of curvature {This will be provided at the exam.}

Recall: *Y'* defines the slope of the tangent to the curve, and *Y"* defines the direction of concavity (<0 down, >0 up).

Other required skills:

1) Applying the **chain rule** to obtain time derivatives correctly. Also need to be able to integrate (i.e. going from velocity expression to a displacement expression).
2) Sketching diagrams **showing the reference systems**, **with unit vectors**, involved and accurately representing the vectors under going the transforms.
3) Correct handling and **presentation of units**.
4) Drawing vectors to **scale** relative to reference frame(s). This is very useful to get a visualization of vector components relative to a given coordinate system.
5) Understanding the difference between $Q' = \frac{dQ}{dx}$ and $\dot{Q} = \frac{dQ}{dt}$ where *Q(x)* is a general expression.