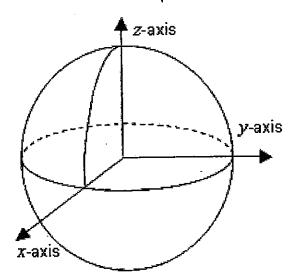
SPACE SYSTEMS ENGINEERING **Orbital Determination from 3 Position Vectors**

The Gibbs Problem:

Given the geocentric position vectors of a space object at three successive times R_1 , R_2 , and R_3 , determine the orbital elements:

North rotational pole



To determine the orbital elements, R and V at any one position is required:

$$\mathbf{V} = \sqrt{\frac{\mu}{ND}} \left(\frac{\mathbf{D} \times \mathbf{r}}{r} + \mathbf{S} \right)$$

Where:

First point of Aries

$$r_1 = (\mathbf{R}_1 \cdot \mathbf{R}_1)^{1/2}$$

$$r_2 = (\mathbf{R}_2 \cdot \mathbf{R}_2)^{1/2}$$

$$r_2 = (\mathbf{R}_2 \cdot \mathbf{R}_2)^{1/2} \qquad \qquad r_3 = (\mathbf{R}_3 \cdot \mathbf{R}_3)^{1/2}$$

$$\mathbf{N} = r_1(\mathbf{R}_2 \times \mathbf{R}_3) + r_2(\mathbf{R}_3 \times \mathbf{R}_1) + r_3(\mathbf{R}_1 \times \mathbf{R}_2)$$

$$\mathbf{D} = \mathbf{R}_2 \times \mathbf{R}_3 + \mathbf{R}_3 \times \mathbf{R}_1 + \mathbf{R}_1 \times \mathbf{R}_2$$

$$S = R_1(r_2 - r_3) + R_2(r_3 - r_1) + R_3(r_1 - r_2)$$