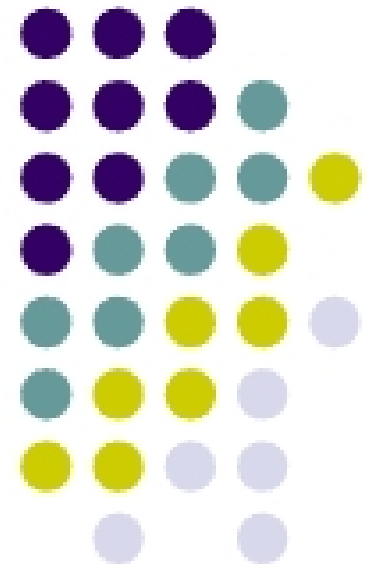


# ME451

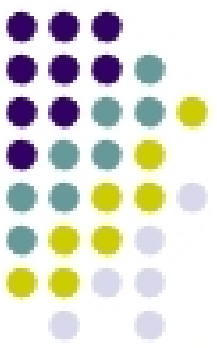
## Kinematics and Dynamics of Machine Systems

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Velocity and Acc. Analysis 3.6  
Singular Configurations of Mechanisms  
Newton-Raphson Method 4.5  
March 3, 2009

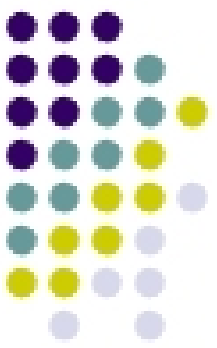


# Before we get started...



- Last Time
  - Discussed driving constraints
    - In Kinematics, it's what it takes to get the mechanism moving
  - Discussed position analysis
    - Set of nonlinear equations, finding solution is not straightforward
  - Implicit Function Theorem
    - Provides sufficient condition for position analysis to locally have a unique solution
- Today:
  - Kinematic Analysis: Velocity and Acceleration Stages (3.6)
  - Discuss Newton-Raphson Method (4.5 – needed for take-home)
  - Singular configuration of mechanisms (3.7, likely on Th)
- Take-home component of the exam available on the website
  - Due on Friday, March 13 at 11:59 PM
  - Exam in one week (March 10)
  - Review session in this room, Monday, 7:15 PM
- No HW assigned

# Velocity Analysis



- This is simple. What is the framework?
- You just found  $\mathbf{q}$  at time  $t$ , that is, the location and orientation of each component of the mechanism at time  $t$ , and now you want to find the velocity of each component (body) of the mechanism
- Taking one time derivative of the constraints leads to the velocity equation:

$$\Phi(\mathbf{q}, t) = 0 \quad \Rightarrow \quad \dot{\Phi}(\mathbf{q}, t) = 0 \quad \Leftrightarrow \quad \Phi_{\mathbf{q}}(\mathbf{q}, t) \cdot \dot{\mathbf{q}} = \nu$$

- In layman's words, once you have  $\mathbf{q}_{(k)}$  you can find  $\dot{\mathbf{q}}_{(k)}$  at time  $t_k$  by solving the linear system

$$\Phi_{\mathbf{q}}(\mathbf{q}_{(k)}, t_k) \cdot \dot{\mathbf{q}}_{(k)} = \nu_{(k)}$$