**Study Guide #2**

**Vector and Conservation Relationships: “boring” math details**

1. Acceleration:  OR 
   1. Write out the ith component of acceleration, i.e. what is ax when using Cartesian coordinates?
   2. Identify local versus convective acceleration.
2. Material derivative 
   1. What is the physical definition of “material derivative”?
   2. ( ) can be a scalar or vector – give examples when used to describe a flow.
3. Conservation of mass at a “point”: 
   1. Reduce this to incompressible flow.
   2. Is steady flow the same net result as incompressible for this equation?
   3. Write an alternative form for conservation of mass using the material derivative for density.
   4. Write the above equation using tensor notation.
4. Differential forces on an element: body and surface
   1. Body forces per volume: *gi* (how do you interpret *gi* since forces are vectors?)
   2. Alternative body force expression:  where *h* is a unit vector along the line of the negative direction of the gravity vector – can you sketch this?
   3. Surface forces: ij
      1. Pressure is “compressive” therefore appears as negative (-P) and always normal to a “surface” – this defines the force direction.
      2. Viscous stresses can be “normal” or “shearing”; in the expression ij how are ij defined, in other words what do they represent?
      3. Write out the surface force second order tensor – how many components exist and what do they mean?
      4. We need the “net” surface force acting on a fluid element:  ; is this a first, second or third order tensor? In evaluating this term in an equation can you identify the direction of this term??
5. At this point you should be able to write out the Cauchy equations and Euler’s Equations and identify terms - do this in tensor notation and write out the terms in Cartesian coordinates.